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GEARING UP for SAFETY

Motor Carrier Safety in a Competitive Environment

CONGRESS OF THE UNITED STATES   OFFICE OF TECHNOLOGY ASSESSMENT

J952-89

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Foreword

Trucks carry three-quarters of the dollar value of all commercial goods transported in the United States, and the speed, convenience, and cost-effectiveness of truck transport make this ratio unlikely to change quickly. The intercity bus and commercial trucking industries are governed by Federal motor carrier regulations, and the Motor Carrier Act of 1980 eliminated many economic restrictions limiting entry to the industry. Federal safety regulations remain basically unchanged, however, and were expanded gradually in range and coverage during the 1980s. Despite this, the number of highway accidents involving heavy trucks climbed during the first half of the decade, prompting concern among public and industry officials, alike. As I write this, the southwest horizon beyond my window—Virginia—is punctuated by a billowing, black cloud from a classic tanker truck accident and fire.

Although many studies on the impacts of deregulation have been undertaken, questions have lingered about the adequacy of existing Federal safety policies and programs. The Committee on Public Works and Transportation and the Subcommittee on Government Activities and Transportation of the Committee on Government Operations, both of the House of Representatives, asked the Office of Technology Assessment to determine how well existing safety policies, regulations, and technologies meet the government's responsibility for ensuring safety in the motor carrier industry. The study was endorsed by the Senate Committee on Commerce, Science, and Transportation.

This report contains the results of that analysis. A review of critical intergovernmental issues for the Department of Transportation and State Governments has been added to the basic questions about the adequacy of Federal standards and programs. During the course of the study, it became clear that the report would have to consider how policy is implemented, and consequently, the relationship between the Department of Transportation and the States, which have become important partners in Federal safety programs. This comprehensive look at motor carrier safety also includes the economic framework of the industry as it affects operations, an analysis of safety data, and a review of research and development needs for safety technologies for both industry and government.

Throughout the study, the advisory panel, review group, workshop participants, and a host of contributors played key roles in developing the major issues and contributed a broad and invaluable range of perspectives. OTA thanks them for their substantial commitment of time and energy. Their participation does not necessarily represent endorsement of the contents of the report, for which OTA bears sole responsibility.

John H Gibbons

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NOTE: OTA appreciates and is grateful for the valuable assistance and thoughtful critiques provided by the advisory panel members. The panel does not, however, necessarily approve, disapprove, or endorse this report. OTA assumes full responsibility for the report and the accuracy of its contents.

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Chapter 1

Summary

Photo credit: Michael Hines, OTA staff

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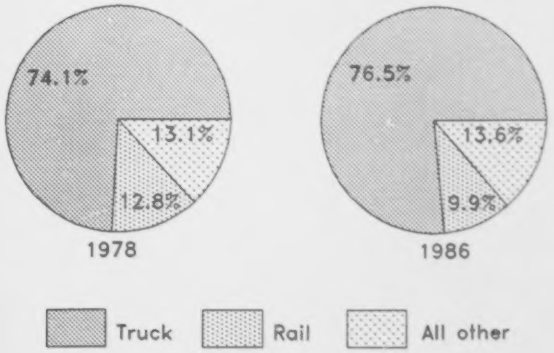
Chapter 1

Summary

Goods ranging from lettuce to automobile parts and steel cables are carried by trucks of all sizes and types from manufacturers to factories, stores, and homes. Freed by the Motor Carrier Act of 1980 from many Federal rules governing entry, pricing, and services, the trucking industry has capitalized on its speed, flexibility, and cost-effectiveness to enhance its dominant role in commercial goods transport—and no serious challenger is on the horizon. Today, trucking accounts for more than three out of every four dollars spent on domestic freight transportation (see figure 1-1). Trucking companies have continued to enlarge their market share by keeping rate increases small over the past 8 years—well below rises in the consumer price index. Rates charged to large volume shippers have actually declined in real terms.[1] Carrier costs, however, have increased more than rates have risen. Companies that have survived the resulting economic squeeze have done so by streamlining operations and cutting costs to improve productivity. Many were unable to modernize sufficiently to compete and succumbed to falling profits and cash flow problems.

Figure 1-1.—Total Freight Revenues by Modal Shares, 1978 and 1986



NOTE: "All other" includes air, pipeline, water, freight forwarders, and miscellaneous shipper costs.

SOURCE: Office of Technology Assessment, 1988; based on data from Transportation Policy Associates, "Transportation in America," November 1986, as cited in American Trucking Associations, Inc., "American Trucking Trends," 1987.

Intercity buses are also part of the motor carrier industry—a part that has not fared well in recent years. Former bus travelers purchased automobiles or were lured by lower air fares available after airline deregulation, shifting to other transport modes in large numbers; the number of revenue bus passengers declined by about 5 percent in the 1980s. Bus companies consolidated service, abandoning routes in lightly populated rural areas, and leaving some former passengers without readily available transportation service.

Despite the vital services they provide, large vehicles, both buses and heavy trucks,[2] are perceived as menaces on the roads by many members of the driving public—much to the concern of the industry. Steady increases in highway traffic have exacerbated long-standing heavy vehicle safety problems; indeed, the number of vehicles now exceeds highway design capacity in many urban areas. Today's trucks and buses are larger and heavier than those of 6 to 8 years ago and travel more miles over the Nation's highways—most of which were designed for automobiles. Highways, such as the Interstate system, which were constructed with truck use in mind, were built for a vehicle comprised of a tractor pulling a 96-inch wide, 40- to 45-foot long trailer—considerably smaller than the combination vehicles now standard. (Figure 1-2 gives examples of some of the vehicles now common on major arteries.) This makes handling today's large trucks safely through turns, on curves and ramps, passing vehicles, and stopping within the appropriate distances a challenge, even for skilled, well-trained, and experienced drivers.

Government officials and safety experts have long sought ways to achieve a responsible balance between ensuring highway safety and facilitating the flow of commerce. For example, after economic deregulation in 1980, a major Federal safety program

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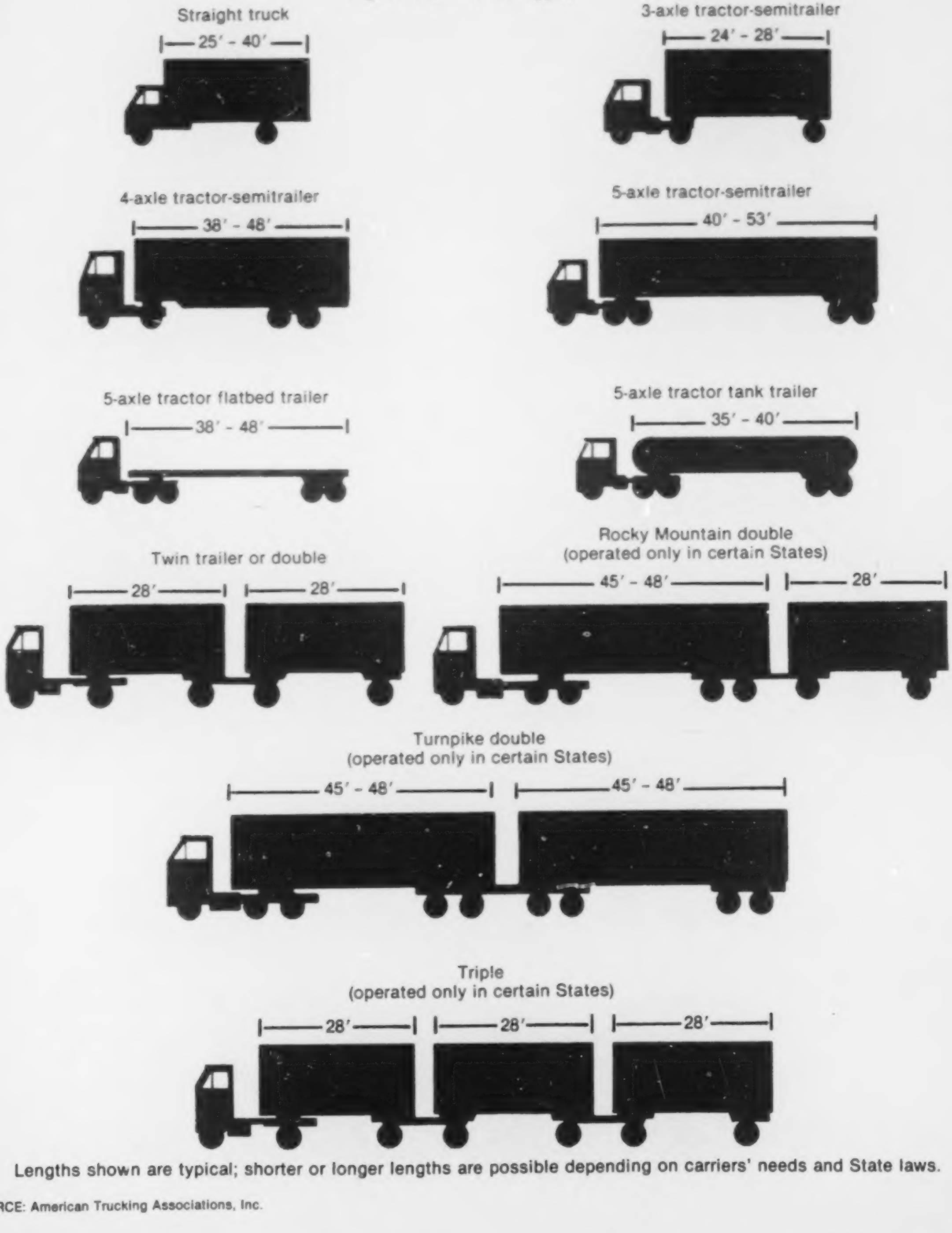
[1] Alex Brown & Sons, Inc., "Wrap-Up of the October 29 Trucking Seminar," unpublished manuscript, December 1987.

[2] Heavy trucks are those with gross vehicle weights of 26,001 pounds and over—the focus for much of this study because the category includes combination tractor-trailers, vehicles that pose the greatest driving challenges and the largest safety hazards.

Figure 1-2.—Truck Types


Straight truck
25′ - 40′
3-axle tractor-semitrailer
24′ - 28′
4-axle tractor-semitrailer
38′ - 48′
5-axle tractor-semitrailer
40′ - 53′
5-axle tractor flatbed trailer
38′ - 48′
5-axle tractor tank trailer
35′ - 40′
Twin trailer or double
28′
28′
Rocky Mountain double
(operated only in certain States)
45′ - 48′
28′
Turnpike double
(operated only in certain States)
45′ - 48′
45′ - 48′
Triple
(operated only in certain States)
28′
28′
28′

Lengths shown are typical; shorter or longer lengths are possible depending on carriers' needs and State laws.

SOURCE: American Trucking Associations, Inc.

was enacted—the Motor Carrier Safety Assistance Program (MCSAP), authorized as part of the Surface Transportation Assistance Act (STAA) of 1982. This program has assisted 48 States in building their safety and enforcement capabilities. Nonetheless, the number of accidents involving heavy trucks increased a total of 15 percent over the 5 years between 1981 and 1986, the last year for which accurate Federal data are available.[3] This increase is slightly greater than the increase in truck-miles traveled.

The number of fatalities in heavy truck accidents has held constant between 4,000 and 5,000 annually over the last 10 years despite the rise in travel, a credit to safety efforts. However, four out of every five people killed in accidents involving truck tractor-trailer combinations are occupants of the other vehicle, usually a car.[4] Between 1 and 2 percent of accidents involving these trucks result in a fatality; the comparable figure for all other types of motor vehicles (except motorcycles) is well under 1 percent. In short, despite the steps taken to improve heavy vehicle safety, concerns persist.

Accidents usually happen as a result of a sequence of events, often initiated by a single occurrence complicated by a number of interacting factors. **Federal data from the National Accident Sampling System (NASS) indicates that the three most common factors associated with heavy vehicle accidents are: 1) speed too fast for conditions; 2) level of training of the driver; and 3) age of the vehicle.** These factors are related to a range of activities that are affected by government and every segment of the motor carrier industry.

To identify changes to existing Federal policies and programs that address these and related safety issues, the Office of Technology Assessment (OTA) took a comprehensive look at the motor carrier industry and the spectrum of safety programs. Research included a review of the numerous Department of Transportation (DOT) and State regulatory, enforcement, and safety programs; accident data resources, truck studies, and accident analyses; and raw accident data. Industry operations and financial performance were assessed, using data from published sources and information provided by both large and small carriers. As a result of this wide-ranging effort, **OTA concluded that addressing motor carrier safety issues successfully requires a comprehensive and stategic approach. Congress' choices are to formulate and enact such an approach into law, to institute more aggressive congressional oversight practices, or to leave the problem in the hands of the executive branch. Action is needed in three key areas:**

- **increased attention to human performance factors, including training guidelines for drivers and maintenance personnel, driver hours of service and fatigue, and management practices, such as hiring, scheduling, and drug and alcohol testing;**
- **stepped-up requirements for technologies to improve safety in over-the-road vehicle operations. These must address vehicle design and equipment requirements, such as tractor-trailer brake compatibility, antilock brakes, and vehicle visibility enhancements, as well as highway structure and design; and**
- **concentrated efforts to integrate government activities across all jurisdictional levels, to increase national uniformity for regulations and enforcement, and to improve regulatory compliance for all motor carriers.**

Box 1-A provides a summary of major policy options and cost estimates.

BACKGROUND

The Motor Carrier Act of 1980 changed or eliminated Federal economic requirements for many segments of the trucking industry, but retained existing safety regulations. Congress has enacted several additional safety measures for motor carriers over the intervening years to enhance Federal safety oversight for interstate commerce, focusing on enforcement, and to a lesser degree, the driver and the ve-

---

[3] OTA calculations, based on National Accident Sampling System data and information provided by National Highway Traffic Safety Administration staff.

[4] OTA calculations, based on data from the Fatal Accident Reporting System.

Box 1-A.—Motor Carrier Safety—Policy Options and DOT Opportunities

	Lead agency:	Costs ($ millions)	
Options and opportunities	coordinate with	Fixed	Recurring
Policy options			
1. Increase MCSAP funding to improve regulatory uniformity and compliance; provide technical assistance for State programs	**OMC:** NHTSA, FHWA, States		200
2. Undertake research on fatigue and sleep problems; revise hours-of-service rules; develop technical guidance for hiring and scheduling	**OMC/NHTSA:** medical community, industry, labor, MCSAP, NTSB	2.0	<1
3. Undertake research to reduce the effects of heavy truck accidents; develop and issue standards and implement programs for improved vehicle visibility, underride guards, and splash and spray reduction, etc.	**NHTSA:** OMC, States, industry	2.5	<1
4. Centralize DOT accident and exposure data collection and analysis; provide technical assistance for State programs	**NHTSA/FHWA:** States	2.3	<1
5. Undertake research on drug impairment levels; develop standards	**OMC:** medical community, NTSB, industry, labor	2.0	<1
DOT opportunities[1]			
1. Develop national guidelines for driver training programs	**OMC:** universities, CVSA, industry	0	0
2. Improve tractor-trailer brake compatibility; complete antilock brake tests and rulemaking	**NHTSA/OMC:** industry	0	<1
3. Revise standards for road signs for heavy vehicles	**FHWA:** NHTSA, States	0	<1
4. Prohibit radar detector use	**FHWA:** NGA, MCSAP officials	0	0

[1] DOT staff costs included additional program costs minimal and shared among groups.

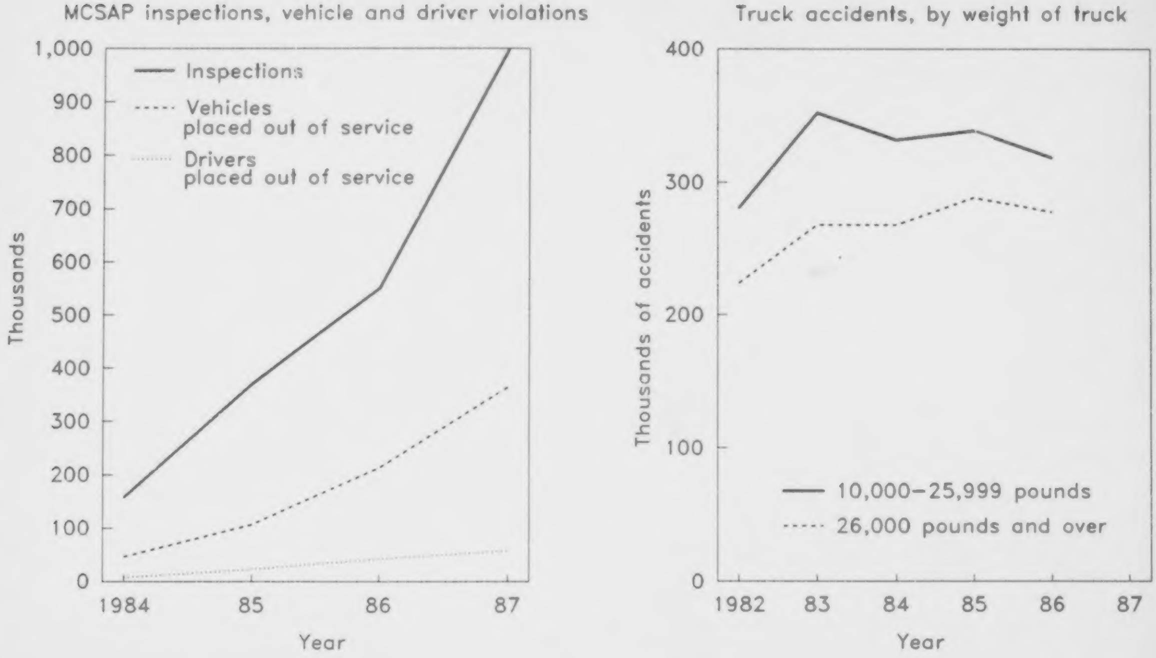
KEY: DOT = U.S. Department of Transportation.
< = less than.
OMC = Office of Motor Carriers.
NHTSA = National Highway Traffic Safety Administration.
FHWA = Federal Highway Administration.
CVSA = Commercial Vehicle Safety Alliance.
MCSAP = Motor Carrier Safety Assistance Program.
NGA = National Governors' Association.
NTSB = National Transportation Safety Board.

SOURCE: Office of Technology Assessment, 1988.

hicles. Major legislation has included MCSAP (1980), requirements for annual truck inspections and for DOT to rate the safety fitness of all carriers (1984), and a national requirement for a single commercial vehicle driver's license (1986).

Such legislation takes time to implement on a national scale and even longer to show results on the highways. Yet, over the past 3 to 4 years, MCSAP has improved State inspection and enforcement capabilities dramatically. This cooperative Federal/State effort may well have played a role in the slight drop in the number of heavy vehicle accidents that occurred in 1986 (see figure 1-3). It has also caused record numbers of trucks and buses to be pulled out of service for violations. In States where enforcement officers target likely violators, as many as 60 percent of commercial vehicles have been pulled out

Figure 1-3.—MCSAP Inspection Rates Compared With Truck Accident Rates



KEY: MCSAP = Motor Carrier Safety Assistance Program.

SOURCE: U.S. Congress, Senate Committee on Commerce, Science, and Transportation, *Motor Carrier Safety Assistance Program: Options Intended to Improve a Generally Successful and Cooperative Federal/State Partnership Promoting Truck and Bus Safety* (Washington, DC: U.S. Government Printing Office, 1988), table 3, p. 18.

SOURCE: Office of Technology Assessment, 1988; based on National Accident Sampling System data, 1981-86. Data for 1987 are not yet available.

of service for violations. **Even in States where efforts are made to perform completely random inspections, 30 percent of inspected vehicles are being put out of service.**[5]

The STAA also authorized operation of trucks with trailers 102-inches wide and 48-feet long, or two 28-foot double trailers, on all Interstate highways and certain roads designated as part of the National Truck Network. The act allowed these vehicles to operate as necessary on other roads to gain "reasonable access" to terminals for pick up and delivery, although States retained responsibility for

Photo credit: Commercial Vehicle Safety Alliance

State inspectors identify safety hazards before an accident occurs.

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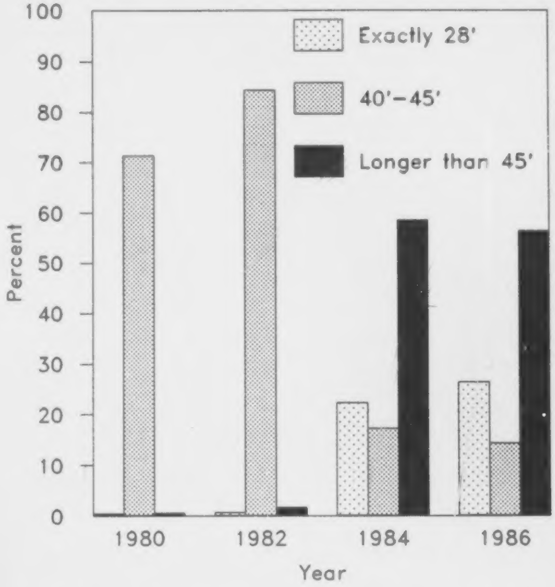
[5] Paul Melander, Tennessee Public Service Commission, personal communication, Mar. 23, 1988.

defining "reasonable access." Carriers moved quickly to take advantage of the opportunity to use larger trailers (see figure 1-4), and longer, wider vehicles now dominate intercity motor transport. In fact, encouraged by potent industry lobbying, many States permit 53-foot trailers or even longer combination vehicles, all of which exceed the limits of existing highway designs. Operating a heavy vehicle safely under such circumstances requires an experienced, well-trained driver, capable of quick and alert performance and accurate judgment and decisionmaking, as well as a well-maintained vehicle.

Several studies have indicated that automobile drivers cause up to 50 percent of multiple vehicle truck accidents. Regardless of who is at fault, accident costs are spread widely, and often are paid as much by the injured, the rescuers, and inconvenienced travelers as by the party that caused the accident. Thus, a comprehensive program to improve carrier safety must address issues related to drivers of both heavy vehicles and automobiles, to the heavy vehicles themselves, and to road design and management. **While a national program to improve motor carrier safety may well bring somewhat higher direct transportation costs, these could be balanced by a reduction in the societal costs of highway accidents, which, it was recently estimated, will reach $65 billion by 1990.**[6]

Figure 1-4.—Trailer Sales Since 1980, by Length



SOURCE: Truck Trailer Manufacturers Association, "Van Trailer Report," various years.

Photo credit: Ohio State Highway Patrol

Heavy truck accidents delay traffic and have significant societal costs.

FRAGMENTED GOVERNMENTAL FRAMEWORK

Attempts to address safety issues in a comprehensive and systematic manner are stymied by the vast varieties and numbers of governmental bodies that share responsibilities for truck safety and the far flung, disparate nature of the trucking industry. At the Federal level, the Interstate Commerce Commission (ICC), and three DOT agencies oversee different aspects of trucking through setting standards and enforcement. Within DOT, the National Highway Traffic Safety Administration (NHTSA) sets and enforces standards and requirements for the manufacture of new vehicles. The Office of Motor Carriers (OMC) in the Federal Highway Administration (FHWA) has regulatory and enforcement responsibility for the drivers, carrier operations, and the companies operating the vehicles. The Research and Special Programs Administration regulates containers used in highway transportation of hazardous materials (see table 1-1). A number of other offices within FHWA set standards for highway design and approve funding programs for State highway construction. These units rarely work closely on carrier safety issues; in fact NHTSA and OMC each have separate advisory groups for truck matters. In Congress, a similar number of committees have jurisdiction over different aspects of motor carrier safety.

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[6] U.S. Congress, House Committee on Public Works and Transportation, *The Status of the Nation's Highways: Conditions and Performance*, Report of the Secretary of Transportation (Washington, DC: U.S. Government Printing Office, 1987).

At the State level, numerous groups play roles, with Governors' offices, State legislatures, and Departments of Transportation, Highways, Police, and Public Safety, as well as regulatory bodies, such as Public Utilities Commissions or Public Service Commissions as major actors. Within States, responsibilities are divided differently, and agencies have separate and often incompatible approaches to activities such as issuing inspection stickers, penalties for overweight trucks, and highway access decisions.

Table 1-1.—Overview of Federal Regulatory Responsibilities for Motor Carrier Safety

Department of Transportation Administration	Senior Official	Responsibilities
Federal Highway Administration (FHWA)	Associate Administrator for Engineering and Program Development	Determines how truck access affects the highway system
	Associate Administrator for Research, Development and Technology	Manages research on the adequacy of highway design to accommodate trucks
	Associate Administrator for Motor Carriers	Establishes and enforces operating regulations for commercial motor carriers; includes driver and maintenance requirements
	Associate Administrator for Policy	Studies the implications of longer combination vehicle used on the Nation's highway system
National Highway Traffic Safety Administration (NHTSA)		Establishes regulations for the manufacture of new vehicles and related equipment; investigates safety-related equipment defects
Research and Special Programs Administration (RSPA)		Establishes and enforces regulations for containers used in used in transportation of hazardous materials

SOURCE: Office of Technology Assessment, 1988.

THE DIVERSE INDUSTRY

The governmental framework seems simple when compared to the motor carrier industry, or more accurately, the industries. The intercity bus industry is but one small segment. Heavy truck operators include companies owning from 1 to 500 or more trucks, doing business as private or for-hire carriers, carriers of exempt commodities, owner-operators, intermodal-operators, and interstate and intrastate carriers (see figure 1-5). Freedom to enter the market and compete for available customers has had far-reaching effects on virtually all of these—diminishing the differences between common and contract carriers and expanding the opportunities for private carriers. The number of ICC-regulated carriers (about 33 percent of the Nation's total number of carriers) more than doubled between 1978 and 1986, with most of the growth in the smallest ICC revenue category, Class III (carriers with revenue under $1 million annually). The number of large (Class I and II) carriers declined slightly over this time period, however, as carriers declared bankruptcy or changed hands (see figure 1-6).

Although many of the new entries were not new to trucking, having previously operated as exempt or private carriers, the services they offered created considerable excess capacity at the same time as the 1981-82 recession and its aftermath damped factory production and shipment levels. As a result, rates tumbled and carrier profit margins fell, even for the historically most profitable carriers (see figure 1-7). While accurate data are hard to acquire since companies leaving the industry need not report to ICC, estimates are that the number of carriers merging or going out of business climbed steadily from under 200 a year in 1978 and 1979 to over 1,500 in 1986.

Surviving carriers have in common a lean, cost-conscious management approach focused on ways to increase market share, often through specialized service. Carriers of all sizes have been affected by rate competition and forced to examine alternatives to utilize capacity and to increase productivity. Companies that have succeeded in meeting specialized market demands or that have a financial cushion adequate to support investments in equipment, facilities, and well-qualified drivers (important for safety) can do well.

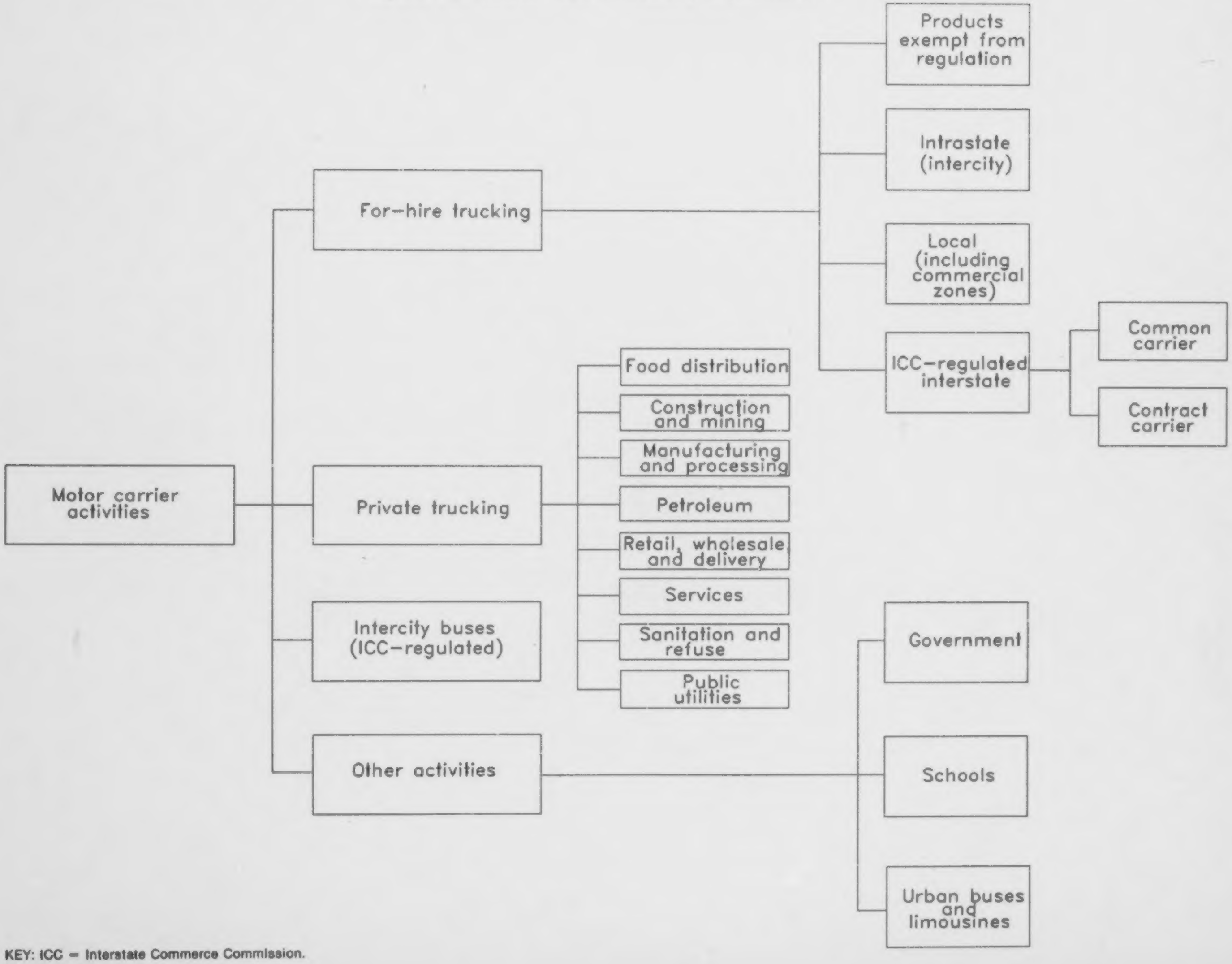
Each carrier has chosen methods that are most cost-effective for its individual operations, and no single best way of managing for safety emerged from OTA's examination. In equipment management, for example, some firms with good safety records keep their tractors for 7 or 8 years, undertaking major engine overhauls at 300,000 miles. Others choose to replace tractors at 4 years or 500,000 miles, finding maintenance too costly after that. Reflecting these varying decisions, over the past 8 years, the median age of heavy trucks in the commercial fleet rose from 6 years in 1978 to 7½ years in 1985, and has settled at about 7 years after strong sales in 1987. Large carriers are standardizing fleets to make maintenance more efficient and enable them to bargain hard with manufacturers for durability and maintenance-free characteristics in their large fleet purchases. However, companies with notable safety records do have in common a commitment to safety and to personnel and scheduling practices that indicate respect for the driver and his or her essential contribution.

The industry relies for economic success on high productivity gained by carrying large volumes in millions of single trips, meeting demanding time schedules, and keeping prices competitive. These business requirements do not make it easy to comply with complex and varying regulations imposed at different governmental levels. **OTA concludes that the economic success of a carrier has an identifiable effect on operations and fleet condition; in fleets having financial difficulties, vehicles are not as well maintained and equipment tends to be older. However, the absence of good data from the period before economic deregulation, the effects on all business activity of the 1982 recession, and the many changes in carrier operations that occurred as the result of other governmental policy decisions, all lead OTA to conclude that no clear link can be established between changes in economic regulation and motor carrier safety.**

HUMAN FACTORS

Accident data show that over 60 percent of accidents are caused by human error. While a good deal is known about the factors that degrade driving performance, **OTA concludes that Federal programs have not focused adequately on developing effective countermeasures.** Inexperienced drivers are particularly susceptible to accidents, and a large number of heavy truck drivers involved in accidents

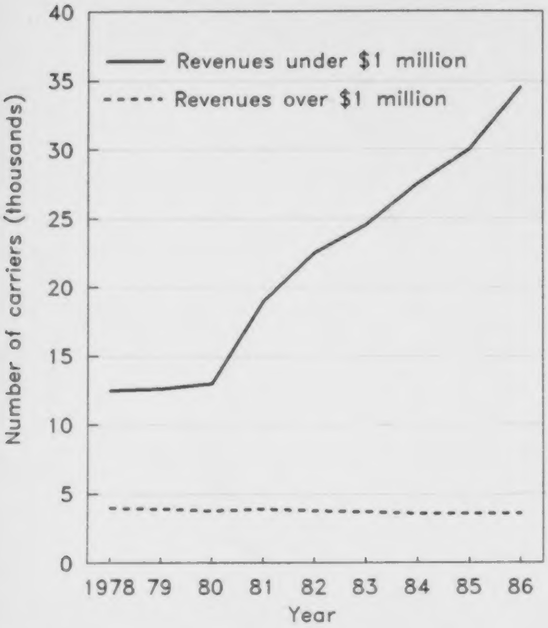
Figure 1-5.—Motor Carrier Industry Organization


Motor carrier activities
For-hire trucking
Private trucking
Intercity buses (ICC-regulated)
Other activities
Products exempt from regulation
Intrastate (intercity)
Local (including commercial zones)
ICC-regulated interstate
Common carrier
Contract carrier
Food distribution
Construction and mining
Manufacturing and processing
Petroleum
Retail, wholesale, and delivery
Services
Sanitation and refuse
Public utilities
Government
Schools
Urban buses and limousines

KEY: ICC = Interstate Commerce Commission.

SOURCE: Office of Technology Assessment, 1988.

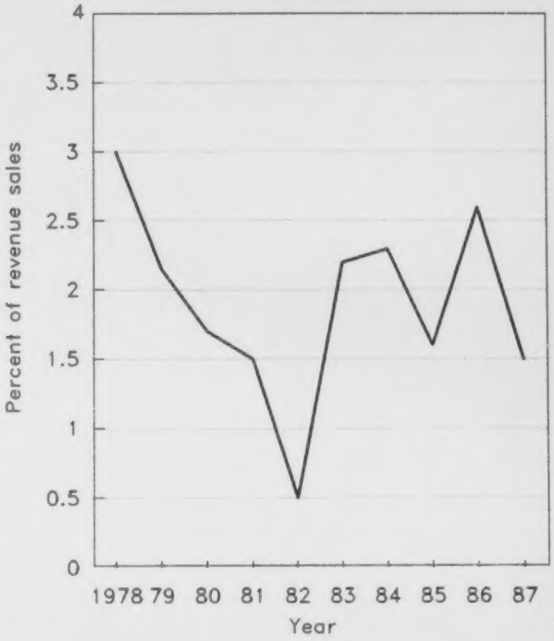
Figure 1-6.—Number of ICC Motor Carriers by Revenue Category, 1978-86



KEY: ICC = Interstate Commerce Commission.

SOURCE: Ronald Roth, American Trucking Associations, Inc., "Trucking: An Overview and Focus on Recent Times," unpublished manuscript, September 1987, chart 14.

Figure 1-7.—Net Profit Margin, 1978-87 (all carriers)



SOURCE: Ronald Roth, American Trucking Associations, Inc., "Trucking: An Overview and Focus on Recent Times," unpublished manuscript, September 1987, chart 25.

have poor driving records—including speeding offenses.

Training

A vital element in preventing accidents is the driver's skill and awareness; both can be increased through appropriate training. Surveys indicate that many heavy truck drivers have not received any formal driver training prior to going on the road, although many companies will hire only drivers with verifiable experience. OTA research shows that many drivers involved in accidents never had any training or significant retraining, and that level of driver training is frequently a factor cited on accident reports. **OTA concludes that special attention to training requirements and close scrutiny of the guidelines for the commercial driver's license test as they are developed by DOT are warranted. To ensure that training issues are adequately addressed, Congress may wish to require national guidelines for driver training and certification for truck driver training programs.** A consensus process for developing and approving the guidelines is important to ensure widespread acceptability. Participants could include officials from training schools, Federal and State regulatory and enforcement agencies, labor, carrier management, and vehicle manufacturers. A key issue is on-the-road experience required of prospective drivers, and to address this issue, **DOT might encourage carriers to develop apprentice programs that follow national guidelines.**

Considerable public and private effort will be necessary to make any new standards and programs effective, and the commitment of carrier management to safety and to implementing new standards will play pivotal roles. Historically, DOT has not been an active player in this area. **Congress may wish to encourage DOT to develop a cooperative government, academic, and private research, education, and outreach program to address management-**

related issues such as driver hiring, screening, and training programs and hours-of-service revisions.

Fatigue and Hours of Service

Research indicates that fatigue can play a major role in accidents, particularly for older drivers and for drivers on the road for 12 hours or more.[7] Moreover, drivers of large trucks have shown significant increases in driving errors and decreases in driver alertness due to fatigue during driving times that are well within the current hours-of-service limit. Greater understanding of the impacts on performance of circadian rhythm (time-of-day) and fatigue is needed so appropriate regulations and changes to driver scheduling can be developed. **OTA concludes that aggressive Federal research programs to address fatigue and sleep issues and to determine their role in truck accidents are top priorities.** DOT has planned several research projects on these subjects for the next 2 years; these projects represent small but important initial steps and deserve support and funding. However, followup will be essential if the research is to bring safety benefits.

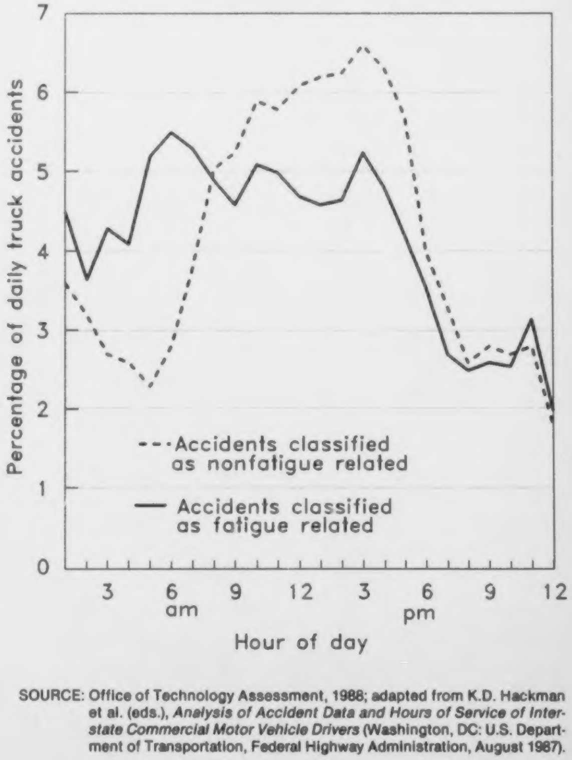
Many heavy truck operations are not conducive to allowing adequate rest for medium- and long-haul drivers. DOT hours-of-service regulations were formulated 50 years ago, and do not take into account the effects of operating on Interstate highways, new vehicle technologies, contemporary economic conditions, or advances in understanding of circadian rhythm, fatigue, and sleep needs. **OTA research points to compelling reasons for DOT to reexamine the hours-of-service regulations, and to develop revised standards based on current knowledge and the around-the-clock operating environment necessary today.**

Other driver-related factors, such as the effect of air quality and vibration in the cab environment on performance and fatigue, need consideration as well. An effective Federal research program on these subjects would require joint efforts by NHTSA and FHWA. Work to address these issues could also include cooperative government-industry studies to explore changes in cab and seat design and feasible scheduling alternatives and training programs. To ensure that all views are heard, independent drivers and representatives of large and small carriers should participate.

Accident Factors

Federal support for research on fatigue could also provide information to help management and drivers understand when drivers are most vulnerable to accidents and how scheduling and procedures might be altered to accommodate sleep needs (see figure 1-8). One practical and achievable outcome of such research would be simple, effective, and inexpensive techniques to screen drivers with sleep disorders, who are at high risk for fatigue-related accidents.

Figure 1-8.—Relationship of Driver Fatigue to Accidents, by Hour of Day



SOURCE: Office of Technology Assessment, 1988; adapted from K.D. Hackman et al. (eds.), *Analysis of Accident Data and Hours of Service of Interstate Commercial Motor Vehicle Drivers* (Washington, DC: U.S. Department of Transportation, Federal Highway Administration, August 1987).

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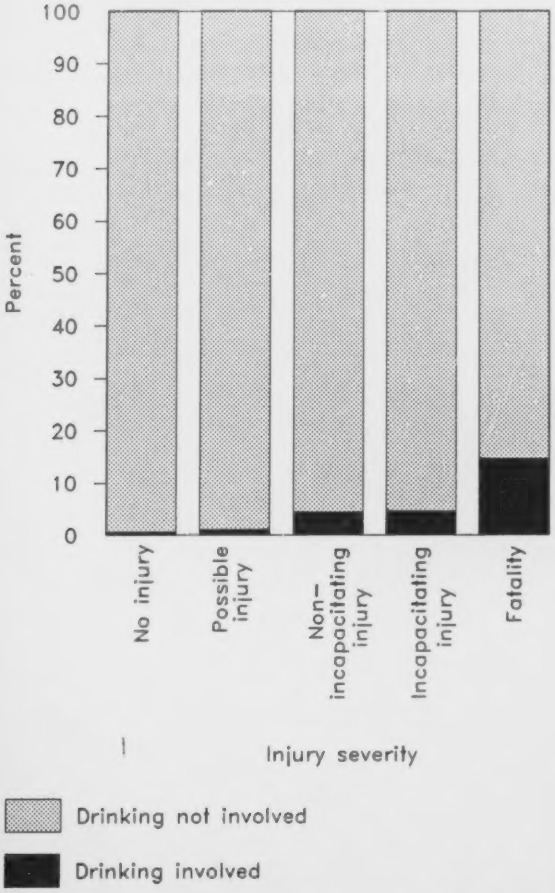
[7] Patrick Hamelin, "Truck Driver's Involvement in Traffic Accidents as Related to Their Shiftworks and Professional Features," *Symposium on the Role of Heavy Freight Vehicles in Traffic Accidents* (Ottawa, Canada: Organisation for Economic Cooperation and Development, April 1987), vol. 2, pp. 3-107.

Drivers under the influence of alcohol are far more likely to have a severe accident (see figure 1-9). Abundant evidence indicates that truck driver performance is impaired by blood-alcohol concentration (BAC) levels well below 0.10 percent and that alcohol and drug use increases both the likelihood and severity of accidents. **Congress may wish to ensure that acceptable BAC levels for truck drivers are set at 0.04 percent, the current level for airline pilots, and to require drug and alcohol screening for all driver applicants, as part of periodic DOT-required physical examinations, and for probable cause.** Research is under way at the National Transportation Safety Board to document truck driver activities for 72 hours prior to a fatal accident to determine drug use and to try to establish impairment levels related to that use. Since a record of previous violations is characteristic of many truck drivers involved in serious accidents, Congress may wish to monitor closely DOT's future decisions related to violations during part-time activities or while off duty.

Figure 1-9.—Injury Severity in Heavy Truck Accidents Relative to Truck Driver Drinking



SOURCE: Office of Technology Assessment, 1988; based on National Accident Sampling System data, 1981-85.

On-Board Computers

On-board computers that record speed, stopping times, brake applications, etc., are management tools that many carriers have used successfully to improve the efficiency of their operations and to hold drivers accountable for their performance. Several carriers requested permission from DOT to substitute records from these computers for driver logbooks, and DOT has ruled that the devices are acceptable. Requiring the devices as a safety measure to improve compliance with the hours-of-service regulations has also been suggested.

In companies where on-board computers are used, fleet managers introduced the devices only after careful dialog with drivers to minimize potential adverse reactions. Many owner-operators view the devices as intrusive and cannot find benefits that justify investment in them. **OTA concludes that while a Federal requirement for on-board recording devices may be premature, Congress may wish to require DOT to plan and implement a program leading toward such a rule. Preparation and education for management, labor, and State enforcement officers are essential to ensure acceptance of these tools as safety devices, prevent their abuse, and assure their usefulness in increasing industry compliance with regulations.**

Public Education

Finally, education programs directed at motor carrier and automobile drivers could enhance awareness of safety issues related to sharing the roads. These programs should focus on the handling and stability characteristics of trucks, the need to maintain adequate distance between vehicles, the longer distances required for a heavy vehicle to stop, and the severe damage that can result from a collision between cars and trucks. **Congress may wish to re-**

quire NHTSA and FHWA to play mutually supportive roles in developing a model program for States to ensure that these messages reach a broad population. Information programs could be incorporated into the process for obtaining and renewing driver licenses.

VEHICLE AND ROADWAY TECHNOLOGIES

While highway system design issues and truck vehicle safety technologies are inextricably linked, they are treated as two separate issues by governments, by carriers, and by vehicle manufacturing industries. Moreover, while data point clearly to vehicle technology problems that have identified technical fixes, only a handful of researchers have devoted similar attention to highway design issues as they affect operation of wider and longer heavy trucks. **OTA finds that a systems approach to commercial vehicle highway safety is a priority for Federal action. DOT agencies, including NHTSA and OMC and highway planning, safety, and design offices in FHWA must work more closely with each other and with industry to address driver, vehicle, and road safety issues systematically.**

Speed and Highway Design

Federal and State accident databases cite "speed too fast for conditions" most frequently as a factor in truck accidents. To determine the appropriate speed for conditions, the driver must understand the operating limits of his vehicle and the configuration of the specific section of the roadway on which he or she is traveling. For example, accident analyses show that a disproportionate share of fatal heavy truck accidents occur on U.S. and State highways, roads usually constructed with lane widths and median markings appropriate for automobiles. Light conditions, weather, and traffic congestion are not major contributors to such accidents. Reconstructing these highways to increase width, passing lane length, and sight distances, and to provide sturdy median barriers would be prohibitively expensive. Thus, the driver, as he or she assesses the appropriate speed and controls the vehicle, is the primary accident prevention tool.

Photo credit: Michael Hines, OTA staff

Heavy trucks travel all types of roads, although most roads were designed for automobiles.

Industry approaches to limiting and controlling vehicle speed vary widely. Some companies train drivers how to operate according to explicit corporate speed policies, and design driver schedules so that trips can be accomplished within the legal duty shift. Other large trucking companies install speed governors set at roughly 57 miles per hour (mph) on their fleets, finding that the need to balance fuel efficiency, safety, and delivery schedules is best met by this method. Still other companies have installed on-board computers to monitor driver speed. On the other hand, many truck drivers, including some employed by large companies, own radar detectors and consider them essential to accomplishing the on-time deliveries required of them by shippers or brokers.

Congress may wish to consider legislation to require speed control devices, such as governors or other devices that measure and record speed only, as tools to control and monitor speed and aid enforcement. In addition, since the primary reason for radar detectors is to alert a driver when the vehicle's speed is being monitored to see whether it is exceeding the speeding limit, Congress may wish to make such devices illegal for all vehicles across the country. Also, model standards for penalties for speeding that are high enough to be a deterrent to violators could be developed.

A reexamination of highway design standards with an awareness of the size of today's heavy trucks could lead to **relatively low-cost safety improvements—revised signs to assist drivers of heavy vehicles in accurately assessing the appropriate speed for roadway limits. Also of importance are revisions to ramp design, intersection, and other roadway standards.** While these are long-term processes and reconstruction of roadways will take longer still, Fed ral efforts could be intensified to assist States in determining appropriate new standards.

Further, in light of the important role of speed in fatal accidents, Congress may wish to reexamine the decision to permit truck speeds of 65 mph on rural Interstate highways. Data analysis for this study leads OTA to conclude that the importance of keeping trucks at speeds compatible with highway design and roadway conditions outweighs any small economic advantages that might accompany faster carrier travel.

Brakes

Defective brakes are the most prevalent vehicle violation uncovered by roadside safety inspections. In addition to brake wear and adjustment problems that affect buses and straight trucks, brake compatibility between tractors and the trailers they pull poses major difficulties. One result of incompatibility between tractor and trailer brakes is a high potential for jackknifing. Bobtails (tractors running without a trailer) and combination trucks running empty pose particular difficulties because of the complicated relationship between brake systems and truck loads. **OTA concludes that overcoming brake incompatibility between tractors and trailers and other brake-related problems are priorities for manufacturers and carriers. Furthermore, active participation by NHTSA is necessary to bring early results and improved standards for brake system components.** Trailer manufacturers as well as tractor makers must be involved in the rulemaking process to ensure the development and use of compatible and well-balanced braking systems. **An all-out joint effort by OMC, NHTSA, the trucking industry, and tractor and trailer manufacturers to address this issue is urgently needed.**

Photo credit: Commercial Vehicle Safety Alliance

Brake defects such as this are the most frequent equipment violations found during roadside inspections.

Another essential step in addressing brake problems is completion of current DOT tests on antilock brake systems to verify their effectiveness under field conditions. Manufacturers are beginning to test tractor-only antilock systems, on the premise that these are currently the most feasible for the complex and diverse U.S. trucking industry. **If the DOT tests are successful, antilock systems could become mandatory equipment by the early 1990s. Key components to successful implementation of the requirement include: 1) lead time for development of standard procedures for mechanics for maintaining and adjusting the brake system, and 2) education and training programs for operators and mechanics to disseminate accurate information on checking and adjusting brakes for varying loads. Full tractor-trailer antilock systems remain the eventual safety goal.**

Equipment Standards

Handling and stability problems increase the likelihood of rollover, particularly for operations involving tractors and double trailers. Tire condition and performance are also key factors in safe operations. Additionally, lethal override/underride accidents, particularly at night, indicate a need for devices to mitigate the effects of these accidents and to make trucks more visible at night. **OTA concludes that NHTSA has lagged badly in proposing upgraded standards in several of these areas. Congress may wish to require NHTSA to move vigorously on rulemaking.**

The Federal Government could play a more active role in determining standards for safety technologies, either as *performance criteria* (which state minimum acceptable capabilities) or as *design standards* (which detail the equipment that must be used).[8] Vehicle equipment compatibility issues are so difficult that a cooperative Federal effort by OMC (FHWA), NHTSA, and industry is needed for solutions.[9] For example, some of the FHWA brake standards are incompatible with NHTSA requirements. As new equipment becomes standard, mechanics will need training in proper techniques and tools. Cooperative industry-government efforts will be especially useful in developing and implementing education and training programs for mechanics to ensure that both new and old systems are maintained properly.

Manufacturers and researchers have experimented with and evaluated splash and spray control methods and devices. Tractor manufacturers have been working on aerodynamically shaped tractors and side deflectors and dams for trailers; one side-benefit is increased splash and spray control. **OTA concludes that NHTSA moved prematurely to close its rulemaking for this problem, and that performance criteria could be developed and phased in for new equipment, based on available knowledge.**

Truck occupants typically do not wear safety belts that can protect them from ejection or hard contact with the cab interior, which can cause serious injury or a fatality. **OTA concludes that a requirement that drivers use three-point seat belts when operating their vehicles could contribute to driver survival.** The implications of cab design and cab equipment location are important subjects for a continuing Federal program of cab crashworthiness research.

Difficulty in designing retrofit equipment adaptable to older vehicles and the evolutionary nature of technology focus manufacturers' R&D efforts toward new vehicles.[10] New requirements for safety equipment concern large firms and individual owner-operators, since refitting and modifying existing fleets or vehicles can have significant costs. Without regulation, industry will balance the degree of benefit against the effort and cost involved in retrofitting a vehicle to determine whether to adopt safety equipment.[11] **Given these difficulties, Congress may wish to require DOT to develop implementation programs for regulations that require retrofits with new technologies.**

The relative operating safety of single and double combinations has been studied extensively, but major differences have not been established, nor could OTA identify significant variation in its own research. Moreover, after an initial learning and adjustment period for doubles operations, fleet owners have found the safety record for both types of operations to be very similar. **OTA concludes that different safety problems are inherent in each design and that appropriate driver training and experience with each can improve operational safety.**

Finally, the cost of educating drivers to use new safety equipment is one that will have to be accounted for in some fashion by the marketplace. Although carriers may need to pay drivers and mechanics more for having technological skills, some of the costs will be offset by reduced accident and insurance costs.

Adopting New Technologies

Since many safety improvements do not translate directly into higher productivity, industry acceptance of new technologies is slow. The fragmentation of the industry hampers dissemination of safety information on new technologies, and legislative and rulemaking processes required to implement new technologies are complex and time-consuming. Although the number of participants may be large (see figure 1-10), government-industry working groups that focus on setting uniform standards, voluntary field testing by industry, and the sharing of experimental data can lead more quickly to acceptable new standards.

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[8] Joe R. Morris, "Safety Implications of Changes in Truck Size and Weight Limits," *Symposium on the Role of Heavy Freight Vehicles in Traffic*, op. cit., footnote 7, vol. 3, pp. 4-14.

[9] Robert Ervin, University of Michigan Transportation Research Institute, in U.S. Congress, Office of Technology Assessment, "Transcript of Proceedings—OTA Workshop on Technologies Affecting Truck Safety," unpublished transcript, Mar. 10, 1987.

[10] P.A. Gustafson, Cummins Engine Co., Inc., personal communication, Apr. 28, 1987.

[11] Farrel L. Krall, Navistar International Corp., personal communication, Apr. 29, 1987.

OTA concludes that Federal education and information programs are essential if requirements for new technologies are to be implemented quickly. Congress may wish to allocate resources and require DOT to undertake such tasks. For example, widespread misunderstanding by operators and some maintenance personnel of how truck brake systems should be installed, adjusted, and maintained, suggests a need for a nationwide education program. Training programs for maintenance personnel are a top priority.

Trade associations and publications could well take the lead in educating carriers, while States could coordinate such measures with their enforcement programs and with State trucking associations. The industry members hardest to reach with such efforts are the owner-operators, since many do not participate in large industry groups. Establishing video instructional displays at truck stops around the country is one method of informing carriers and drivers of the risks they take by operating trucks with deficient brakes. Ways to avoid and correct safety problems can also be presented at such displays.

The adoption of safety-related technologies by trucking firms and owner-operators is not an automatic process. Improved safety equipment that has clear economic benefit may be quickly utilized by industry.[12] Many firms that can benefit from a particular safety technology (e.g., brake retarders for firms that operate frequently over mountainous routes) have already taken steps to adopt it.[13] However, the economic benefit of safety equipment is not always apparent to industry. **OTA finds that in this situation, setting Federal performance standards for equipment through rulemaking, and ensuring that the standards apply equally to all motor carriers, regardless of classification, is appropriate.** Rough estimates of the costs of new safety equipment may be found in table 1-2.

Table 1-2.—Estimated Costs of Safety Equipment for New Vehicles

Equipment option	Cost per vehicle[a] (1988 dollars)
Tractor:	
1. Three-point seat belts	50
2. Antilock brakes	2,100
3. Brake adjustment indicators and automatic slack adjusters (front axle)	150
4. Brake adjustment indicators and automatic slack adjusters (rear axle)	280
5. Splash/spray suppression	300
6. Reflectors	15
Tractor total	2,895[b]
Trailer:	
1. Conspicuity devices	125
2. Side underride guards	1,000
3. Automatic slack adjusters	450
4. Brake adjustment indicator	150
5. Antilock brakes (not currently offered in U.S.)	1,200
6. Splash/spray suppression	300
7. Rear underride guard	100
Trailer total	3,325[c]

NOTE: The Nation's registered tractor/trailer fleet included 1.1 million truck-tractors and 3.4 million trailers in 1986.

[a] Average or mid-range cost based on current production levels.

[b] Represents a 3 percent addition to tractor cost, based on $88,500 average tractor cost for 1987.

[c] Represents a 30 percent addition to dry van trailer cost, based on $11,000 average trailer cost (closed-top, dry freight van) for 1987.

SOURCE: Office of Technology Assessment, 1988; based on estimates from the American Trucking Associations, National Highway Traffic Safety Administration, U.S. Department of Commerce, Bureau of the Census, Motor Vehicle Manufacturers Association, and several trailer manufacturers, August 1988.

GOVERNMENTAL COORDINATION

Congressional mandates and DOT actions since 1980, such as requirements for annual vehicle inspections and more stringent standards for driver licensing, represent steps toward greater safety. A comprehensive national truck safety program requires continuing such programs and establishing

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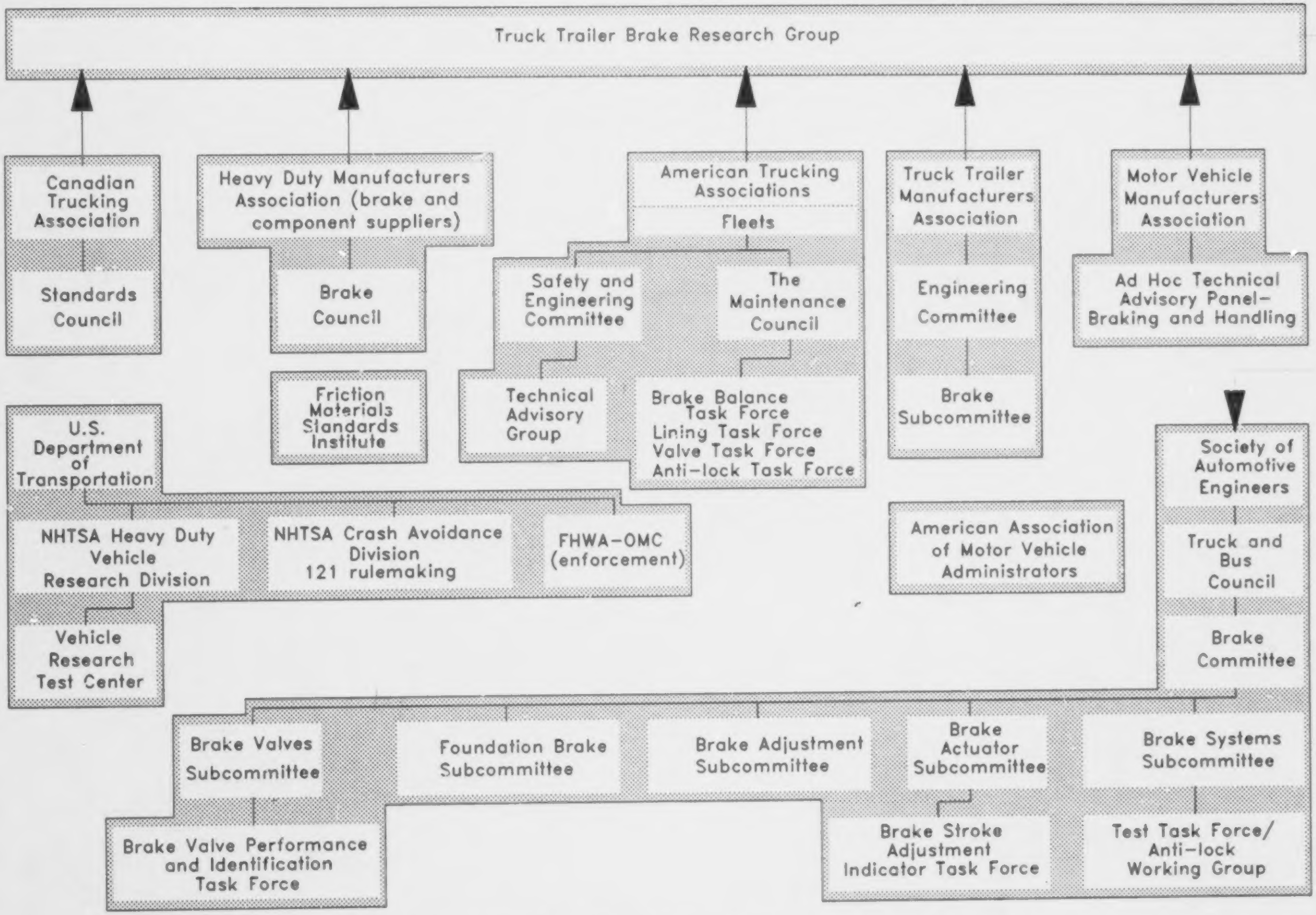
[12] Brian O'Neill, Insurance Institute of Highway Safety, in Office of Technology Assessment, op. cit., footnote 9, p. 109; and Ernie Vaughn, Owner-Operators Independent Truck Drivers Association, in Office of Technology Assessment, op. cit., footnote 9, p. 33.

[13] William Leasure, National Highway Traffic Safety Administration, in Office of Technology Assessment, op. cit., footnote 9, p. 170.

Figure 1-10.—Organizations Concerned With Brake Standards


Truck Trailer Brake Research Group
Canadian Trucking Association
Standards Council
Heavy Duty Manufacturers Association (brake and component suppliers)
Brake Council
Friction Materials Standards Institute
American Trucking Associations
Fleets
Safety and Engineering Committee
The Maintenance Council
Technical Advisory Group
Brake Balance Task Force
Lining Task Force
Valve Task Force
Anti-lock Task Force
Truck Trailer Manufacturers Association
Engineering Committee
Brake Subcommittee
Motor Vehicle Manufacturers Association
Ad Hoc Technical Advisory Panel—Braking and Handling
U.S. Department of Transportation
NHTSA Heavy Duty Vehicle Research Division
NHTSA Crash Avoidance Division 121 rulemaking
FHWA-OMC (enforcement)
Vehicle Research Test Center
American Association of Motor Vehicle Administrators
Society of Automotive Engineers
Truck and Bus Council
Brake Committee
Brake Valves Subcommittee
Foundation Brake Subcommittee
Brake Adjustment Subcommittee
Brake Actuator Subcommittee
Brake Systems Subcommittee
Brake Valve Performance and Identification Task Force
Brake Stroke Adjustment Indicator Task Force
Test Task Force/ Anti-lock Working Group

KEY: NHTSA = National Highway Traffic Safety Administration; FHWA = Federal Highway Administration; OMC = Office of Motor Carriers.

SOURCE: Office of Technology Assessment, 1988; based on information from the American Trucking Associations, 1987.

a far more systematic Federal-State approach. **OTA concludes that two issues are top priorities: 1) improving State enforcement capabilities and regulatory uniformity, and 2) better coordination and cooperation among agencies within DOT.**

State Issues

MCSAP has firmly established the role of States as an essential adjunct to Federal safety efforts. **Continued Federal financial support for State inspection and enforcement activities through MCSAP is crucial. Because additional trained personnel are needed across the country, Congress may wish to increase funding for this useful program. Additional State activities could enhance safety in a number of areas.**

Monitoring industry through terminal audits and ensuring the safety fitness of all motor carriers are important components of a systematic safety program. DOT has made some progress in assigning fitness ratings to the large numbers of unrated motor carriers, mostly small operators, who entered the trucking industry after deregulation. However, the safety fitness of the private fleets that provide over half of commercial truck transport must also be evaluated, and Federal personnel levels are inadequate for this task. Because State audit programs are indispensable additions to Federal enforcement efforts, **Congress may wish to require DOT to develop guidelines and handbooks for States and to encourage more States to train inspectors and begin auditing carriers.** Efforts by FHWA to improve regulatory compliance materials for industry would be helpful as models for the States as well.

OTA concludes that industry complaints about inconsistent State inspection and enforcement procedures and penalties are symptoms of the need for stronger Federal and State efforts toward national uniformity. The Commercial Vehicle Safety Alliance's (CVSA) goal of establishing uniform inspection and out-of-service criteria provides an excellent model for States to use in working together toward consistent nationwide programs. However, efforts will be ineffective unless State governments make the commitment to have all their own agencies cooperate toward this goal. Moreover, intrastate motor carrier operators are subject to uniform safety controls only if Federal regulations have been adopted and are enforced by the States. **Congress may wish to consider requiring all States to participate in MCSAP and adopt and enforce Federal regulations.** To assist in resolving current conflicts in State agency agendas, strong DOT support for consistent implementation of enforcement programs will be needed once FHWA's review of State laws and regulations has been completed and State safety laws evaluated.

Congress may wish to require DOT to provide technical assistance and information on safety regulations and enforcement issues for State officials, law enforcement personnel, and judges. Educational materials could be distributed to States and motor carriers on: 1) Federal safety requirements, 2) model programs for amending laws, 3) implementing Federal standards, and 4) developing an information clearinghouse. An enforcement handbook could provide general guidance on the safety regulations and safety factors to consider when setting penalty amounts for various types of violations. Involving State executive and legislative bodies, bar associations, and enforcement organizations, such as State Attornies General and police chiefs, in the process could help gain acceptance from all agencies of the need for a uniform approach.

DOT has issued a rule, effective in November 1988, eliminating a long-standing regulatory loophole—the Commercial Zone Exemption as it applies to safety regulations in large urban regions. **Congress may wish to ensure that this and other safety exemptions are eliminated completely and quickly.** State and local enforcement officers will need capability to monitor and enforce safety requirements for commercial vehicles in urban commercial areas.

The public safety requires that motor carrier safety regulations are independent of commodity, corporate form, type of operation, or destination of the cargo—the traditional bases of regulation and often the bases for exemptions. Trucks operating in intrastate, private, government, and exempt services perform a major share of the Nation's motor carrier transportation. While safety regulations have gradually been extended to these carriers, **OTA concludes that a comprehensive heavy vehicle safety program must extend safety regulations to all heavy vehicles and operators in all States. The need for safety does not vary with the type of**

operation, and no exemptions from safety regulations, including the Commercial Driver's License, are warranted.

Access

The motor carrier industry is a focal point for many conflicting demands. Shippers, especially those of bulky lightweight products, such as packaged foods or paper goods, push for larger trailers to carry more goods—at minimal extra cost. To capture this business, carriers have purchased new trailers larger than drivers are accustomed to, and joined shippers in convincing State legislatures that trailers as long as 53 feet can operate safely on State roads.

In the Motor Carrier Act of 1984, Congress made clear that decisions on access to State roads for large trucks are the province of the States, not the Federal Government. Resolving the conflicts inherent between industry's push for larger and longer vehicles and the limitations of the Nation's road network requires Federal and State officials to work closely with each other and with shippers and carriers. States have found developing routes and communicating access decisions clearly to industry to be complex and difficult tasks, requiring hard work, patience, good will, and good humor from all parties. Where the process has failed, carriers travel on the routes they deem necessary to reach their destinations, often using narrow rural or urban roadways that are unsuitable for the large vehicles and violating State law.

OTA concludes that varying State access, inspection, and enforcement policies pose significant problems for industry and can adversely affect highway safety when drivers detour on back roads to avoid the delays that often result. Congress may wish to require DOT to play a more active role in facilitating State-industry dialog and resolving these difficult issues. Technology transfer for innovative solutions and working actively with appropriate State and industry organizations are two possible approaches. (For further discussion of technical aspects of the access issue, see chapter 5.)

Photo credit: Land Line

States determine which roads heavy trucks may travel to reach terminals such as this one to pick up and deliver goods in urban areas.

DOT Programs

OTA finds that the division of responsibility for different facets of roadway, vehicle, and driver issues among multiple agencies hampers safety problem solving within DOT. To be able to respond effectively to congressional safety directives, DOT will need to coordinate its agencies. DOT's program to implement the commercial driver's license requirement is a commendable exception; it could serve as a model for efforts to deal with equipment requirements and highway design issues. **Congress may wish to require DOT to develop a plan to integrate the technical expertise now divided between NHTSA and the motor carrier and highway design sections of FHWA to address issues such as roadway and vehicle compatibility guidelines, upgraded safety equipment standards, national training guidelines for drivers and maintenance personnel, accident reduction and mitigation strategies, and data collection and analysis.**

OTA further concludes that DOT agencies need to coordinate in collecting and analyzing data, conducting research programs, and developing regulatory proposals. Although NHTSA and OMC in FHWA do review some of each other's research projects, this is the exception rather than the rule. Establishing special working groups to address issues of common concern, jointly funding research activities, and sharing staff expertise are examples of strategies that could be used.

SAFETY DATA RESOURCES

Accurate, uniform, and representative information that gives sufficient detail for analysis is essential for informed policy decisions on motor carrier safety issues. Objective data are needed to identify highway design limitations and problems and to evaluate the point at which technologies are reliable and cost-effective. **However, OTA concludes that, with few exceptions, existing heavy truck data and information resources have deficiencies that limit their value in supporting safety policies and programs.** In general, Federal data collection suffers from lack of uniformity, some duplication, inadequate quality control, poor handling, and outdated storage systems. **Furthermore, OTA finds that no effective central DOT analysis capability exists, and that this deficiency seriously hinders DOT's policymaking. Congress may wish to require DOT to establish such a centralized capability and develop a comprehensive program to gather, review, and analyze relevant data.** Although some of the existing data are useful for analyzing particular truck safety issues, none of the national accident databases is ideally suited for addressing all truck safety issues (see table 1-3).

NASS, NHTSA's major data source, includes accident data from 1981 to the present. NASS selects accidents, based on a statistically based sampling scheme, permitting the derivation of estimates for national accident totals and annual trends. Changes made to NASS for 1988 (see chapter 7) are likely to make it more difficult to conduct detailed truck and bus accident causal studies using this database.

State accident reporting systems present several promising alternatives because they can represent a census of accidents. However, the lack of uniformity among State data presents problems for extrapolating findings to the national level. The efforts of NHTSA in establishing the CARDfile, and of FHWA working with CVSA and the National Governors' Association in striving for more uniform State accident reporting practices are commendable efforts to address this issue.

A NASS-style approach focused on heavy vehicles could be a cost-effective prerequisite to a truck and bus accident data system, for it allows a sampling of operations by both geography and road use. To provide accurate and comprehensive information, each accident investigation could be handled by field staff that examines the vehicle and the accident site, interviews vehicle occupants, and reviews medical and driver records. For this option to be realized, additional funds will be needed both to restore the original approach and to expand the system to meet truck safety concerns, including training of field teams in truck accident investigation.

FHWA currently has a uniform data collection demonstration project under way in the midwest. FHWA could work actively with other States to expand accident report forms to accommodate truck detail and to establish uniform reporting thresholds and forms for data elements. Both of these developments would enhance truck safety information and furnish a statewide census of accident history. NHTSA's advice and expertise would be invaluable, regardless of which agency took the lead.

The cost of either an accident or an exposure data collection program is a function of the desired precision in the estimates. Close to 300 sampling units would be required to achieve reasonable confidence levels for determining accident rates for different truck types, at a total annual cost of close to $2 million. In addition, the logistical demands of establishing and maintaining cooperative arrangements with each jurisdiction are formidable. More economical alternatives include continuing and expanding existing data collection instruments, although their deficiencies are likely to persist. Given the massive scale of trucking activity, and the comparatively detailed safety information available for air, rail, and marine transportation, these are important tradeoffs to consider.

OTA finds that uniformity between accident and exposure data, and accuracy in estimating truck movements (see tables 1-3 and 1-4) are priority needs. Congress may wish to consider extending FHWA's reporting requirements to include an annual report from all motor carriers, including intrastate operators and those currently exempt from Federal reporting requirements. Information could include the number of trucks owned and miles traveled. To keep track of heavy vehicles, a Federal-State cooperative truck registration database could be developed in conjunction with State vehicle registration requirements. An FHWA database such as SAFETYNET could be used if modifications to the system can be made.

Inspection and Enforcement Data

Under MCSAP, a wide range of State inspection and enforcement data is being amassed that provides useful information for safety analyses. Although the process by which vehicles and companies are targeted for inspection varies between States, the inspection results are reported in a uniform way. SAFETYNET, the enforcement database developed for MCSAP, must mature before its information can be available in an automated form on a national scale, but at that time it will be a valuable resource.

Additional DOT technical assistance for State agencies in developing more uniform data management systems and analytical capabilities, especially in tracking preventable accidents and violation statistics, would be an effective use of limited funding. States could use this information to target carriers for audits and inspections. As FHWA and ICC implement new procedures for assessing the safety fitness of commercial vehicle operators, explicit procedures for monitoring ongoing safety performance will be needed. State personnel and FHWA field inspectors alike could benefit from consistent guidelines for deciding whether to initiate a compliance education program or an enforcement action.

Market Entry, Exit, and Financial Performance

Little public data is available on the financial performance of the industry, and ICC has required less and less reporting over the past 8 to 10 years. **OTA concludes that the ICC reporting system has dwindled to a point where it no longer adequately monitors carrier market entry, exit, and financial performance. The current lack of information presents a significant problem for both safety-related and broad policy decisions.** Obtaining sufficient information would require a dramatic reversal of ICC policy to include Class III carrier registrations, requests for exemptions, and sufficient detail in the data elements to track some degree of financial performance. Substantial data will be needed to restore this system so that it serves a useful purpose for evaluating truck safety. Congress may wish to require ICC to collect such data or place responsibility for doing so with DOT as part of a national motor carrier safety program.

Table 1-3.—Truck Safety Information Systems (Accident Data)

Database	Kept by	Years	Strengths	Weaknesses
50-T (part of MCMIS)	FHWA, Office of Motor Carriers	1973 to present	• Good detail on truck accident characteristics • Exclusive truck focus	• Missing several portions of the truck population • Concern over accuracy and completeness of reports • Relies on carrier participation
FHWA, Special Monitoring Study	FHWA, Office of Highway Information	1983 to present	• Involves accident and exposure data • Exclusive truck focus	• Restricted to aggregate accident reporting • Limited in terms of number of participating States • Missing some truck detail
NASS	NHTSA, National Center for Statistics and Analysis	1979 to present	• Statistical sampling design • Comprehensiveness of accident investigation • Reasonably good detail on truck accident characteristics • National estimates of accident frequency	• Small number of heavy truck accidents in database • Detailed causal analysis sometimes difficult
FARS	NHTSA, National Center for Statistics and Analysis	1975 to present	• Census of all fatal accidents • Comprehensiveness of accident investigation	• Limited details on truck configuration and operation • Nonfatal accidents not represented
NTSB	NTSB	1986 to 1987, single collection	• Comprehensiveness of accident investigation • Good detail on truck characteristics • Exclusive truck focus	• Limited sample of accidents under investigation, not representative of truck crashes generally
State databases	Various State regulatory agencies		• Census of all accident types	• Based solely on police reports at scene • Varying detail on truck accident characteristics • Lack of uniformity from State to State
CARDfile	NHTSA	1982 to present	• Census from several States • Uniformity in reporting format	• Limited truck detail due, in part, to limited uniform variables listed • Based solely on police reports at scene • Limited to a few States
Motor carrier industry	Individual carriers, trade associations		• Some individual carriers maintain excellent detail on accidents and movements • Exclusive truck focus	• Individual carrier represents single observation in industry • Access to individual carrier records is not in the public domain • Trade associations report accident rates but not details on accident characteristics
Insurance companies	Individual companies, ISO		• Detailed financial and statistical data on truck insurance policies and claims	• Aggregate reporting of information by insurers • Primary concern over loss ratio rather than accident causation
UMTRI	UMTRI	1980 to present	• Combines coverage of FARS with detail of 50-T • Post-accident investigation to complete missing information • Exclusive truck focus	• Reliance on information provided by carrier during post-accident investigation • Restricted to fatal accidents

KEY: MCMIS = Motor Carrier Management Information System; FHWA = Federal Highway Administration; NASS = National Accident Sampling System; FARS = Fatal Accident Reporting System; CARDfile = Crash Avoidance Research Datafile; NTSB = National Transportation Safety Board; NHTSA = National Highway Traffic Safety Administration; ISO = Insurance Services Offices, Inc; UMTRI = University of Michigan Transportation Research Institute.

SOURCE: Office of Technology Assessment, 1988.

Table 1-4.—Truck Safety Information Systems (Exposure Data)

Database	Kept by	Years	Strengths	Weaknesses
TIUS	Bureau of the Census	Every 5 years, most recently in 1982	• Covers all trucks used in the United States • Sample biased toward heavy trucks • Exclusive truck focus	• No commodity flow data • Only rudimentary commodity information • Reflects tractor use, not trailer use • Based on owner response
CTS	Bureau of the Census	Since 1963, every 5 years	• Multimodal • Cross-checked against the Census of Manufacturers • Provides flow data	• Shipment data on some products are missing • Only shipments from point of manufacture to first destination are reported • Nonuniformity between surveys • Voluntary data submission
Motor Carrier Census File (part of MCMIS)	FHWA	Most recent 5 years	• Comprehensive listing of carriers and truck fleet operators • Exclusive truck focus	• Many carriers missing from database • No commodity flow data
HPMS	FHWA	Annually	• Statistical sampling design • Detail on roadway characteristics	• Limited truck classification detail
TWS	FHWA	Annually	• Truck classification and weight data • Exclusive truck focus	• Counting sites are not statistically representative • Method of data collection varies and is subject to observer error
Motor carrier industry	Individual carriers, trade associations		• Aggregate statistics on tons, ton-miles, and truck registrations • Detailed flow records from individual carriers and shippers; can merge with similar accident records • Exclusive truck focus	• Truck data are based principally on LTL carriers • Individual carrier represents single observation in industry • Access to individual carrier records is not in public domain
NMTDB	Transportation Research and Marketing (consulting firm)	1977 to present	• Focuses on long-distance truck movements • Good truck and operator classification detail • Exclusive truck focus	• Purposely excludes short-haul truck movements, especially in Northeast • Not in public domain
NTTIS	UMTRI	1986 to 1987, single collection	• Good truck and operator classification detail • Disaggregate and aggregate analysis possible • Exclusive truck focus	• Relatively small number of observations • Single collection

KEY: TIUS = Truck Inventory and Use Survey; CTS = Commodity Transportation Survey; MCMIS = Motor Carrier Management Information System; FHWA = Federal Highway Administration; HPMS = Highway Performance Monitoring System; TWS = Truck Weight Study; LTL = less-than-truckload; NMTDB = National Motor Truck Data Base; NTTIS = National Truck Trip Information Survey; UMTRI = University of Michigan Transportation Research Institute.

SOURCE: Office of Technology Assessment, 1988.

CARRIER ISSUES

Trucking is a tremendously complex industry with numerous market segments; each is served by a variety of motor carriers, making generalizations difficult. Changes in the economic regulation of the motor carrier industry had sweeping effects on market entry, operations, costs and pricing, employment policies and labor relations (including wage levels), and technology development. The distinctions between various types of regulated motor carriers have greatly diminished since deregulation, and entry opportunities for private carriers and owner-operators have increased.

The nature and volume of the business conducted by various segments of the trucking industry have also changed. The largest general commodity carriers now tend to specialize in less-than-truckload (LTL) shipments (under 10,000 pounds). Many large LTL carriers have failed since deregulation, and few new ones have entered the market. However, several of the largest nationwide LTL carriers have expanded and prospered, concentrating business in this segment. These firms compete fiercely for market share.

At the same time, the interstate truckload (TL) industry has become more diverse and dispersed. New entrants in the TL segment tend to be small and nonunion carriers, often from the ranks of owner-operators, who are a key part of this trucking fleet. However, to compete successfully as individual entrepreneurs, owner-operators must drive long hours and accept TL backhauls at low rates, circumstances that create physical, psychological, and economic hardships.

Factors are at work to tip the balance of TL operations toward larger carriers with more capital to invest. Successful TL operations currently stress high-quality service, using high-capacity, specialized equipment and utilizing their assets and labor productively to serve targeted market niches. Concerned about the reliability of leased equipment and drivers, carriers with sufficient resources buy their own equipment and employ company drivers. Others, such as automobile carriers, select and train drivers carefully to handle safely their highly specialized, complex equipment that is difficult to lease. Productivity is high enough that shippers pick these high-service carriers for both service and unit price, and they become "core" carriers, capturing a large portion of the TL freight from major shippers. Owner-operators face continued business pressure from these trends.

Photo credit: Karen Mathiasen, OTA staff

Automobile carriers train drivers to handle special equipment and valuable cargo.

Profits

Profit margins have fallen even for the most successful carriers, a product of intense price competition caused partly by changes in manufacturing and partly by continuing overcapacity. Carriers' expenses per ton-mile are up 75 percent since 1978, while revenues have increased only 54 percent. General freight revenues per ton-mile have increased slightly more than the consumer price index since 1978, but have not matched price increases in the general economy, particularly for large shippers and those in highly competitive city-pair traffic lanes. Carriers that serve small shippers and those in less competitive markets have fared better.

Capacity

One major reason for the high number of motor carrier failures over the past 8 years was the overcapacity that existed in the regulated environment. Despite the failures, however, industry analysts indicate that for several reasons, some overcapacity persists. While the number of heavy trucks registered nationwide has declined slightly, trailers used now are longer and wider, and double trailers, which have significantly greater carrying capacity, have become commonplace on the Interstate system. In addition, industry data show all trucks are being used more productively; they are driven more miles annually and spend longer hours traveling each day.

Rate discounting has made low labor costs and high productivity essential to survival; thus carriers have found it difficult to increase driver wages and improve arduous work conditions. Nonetheless, the need to keep trucks moving has made many carriers focus on ways to make driving a more attractive occupation. Many successful companies have had to provide extra incentives to attract enough drivers, since the traditional driver pool has been shrinking.

Longer vehicles, double trailers, heavier weights, a shortage of qualified drivers, and a competitive marketplace, all have important implications for heavy truck safety. Overcapacity leads to price discounting and shrunken profit margins, creating difficult economic trade-offs for decisions about investment in safety-related equipment and safety-conscious hiring and scheduling practices. Competition, increased operating costs, and low, erratic profit margins create a need to control costs that can lead to shortchanging safety-related driver training, truck maintenance, and equipment improvements. Carriers are, in general, interested in safety, but they will measure investments in new safety equipment and technologies against tangible economic rewards. Cost and safety trade-offs are particularly problematic for owner-operators and small carriers, who have to generate revenue regularly to stay in business and may have no regular operations base or maintenance facility. **OTA concludes that Federal safety regulations will affect carriers economically with varying severity, depending on their financial reserves and stability.** Congress will want to keep this in mind as it weighs policies related to safety.

Chapter 2

The Motor Carrier Industry—A Profile

DELI & AUTO SERVICE

Photo credit: Tse-Sung Wu, OTA staff

Bobtail tractor

Photo credit: Land Line

Flatbed trailer

TRUCK STOP
montgomery

Photo credit: Karen Mathiasen, OTA staff

Conventional tractor

Photo credit: Freightliner Corp.

Cab-over-engine tractor

Photo credit: Land Line

Tanker

Photo credit: Karen Mathiasen, OTA staff

Automobile carrier

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Chapter 2

The Motor Carrier Industry—A Profile

The motor carrier industry moves goods and materials between shippers and receivers all across the Nation and carries passengers between large and small cities. Motor carriers are our most ubiquitous freight mode, using the extensive U.S. highway network to link markets of all types, sizes, and locations and serving many points that lack rail or air service. The numbers of motor carriers grew dramatically during the 1980s, with many carriers of all sizes moving to specialize in different segments of the market. This wide variety of activities makes the industry difficult to categorize.

Nonetheless, motor carrier safety concerns and issues are best viewed in their industry context, so that policy changes to improve safety recognize and address the economic and physical characteristics of the industry. Motor carrier accidents have immediate economic impacts on carriers, drivers, and shippers of the freight being transported. However, motor carrier safety is also a prime governmental and public concern, because carriers share the roads with automobiles and other personal-use vehicles. Moreover, the societal costs of traffic accidents are heavy. The Secretary of Transportation recently projected that the annual economic cost of highway accidents could be $65 billion in the year 2000.[1]

This chapter presents an economic and business profile of the motor carrier industry, describing the vehicle fleet, industry characteristics, competitive conditions, industry trends, and major policy developments. The information focuses on the large, heavy trucks that are a prime safety concern and provides a framework for evaluating specific safety-related issues.

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[1] U.S. Congress, House Committee on Public Works and Transportation, *The Status of the Nation's Highways: Conditions and Performance*, Report of the Secretary of Transportation (Washington, DC: U.S. Government Printing Office, 1987). Cost projections are in constant 1985 dollars.

THE NATION'S TRUCK FLEET

Number of Trucks

Industry-wide data on the domestic trucking fleet are available from several sources, although data on the entire population of trucks, including both interstate and local carriers, suffer from severe shortcomings (see chapter 7). The Federal Highway Administration (FHWA) compiles and publishes data on all motor vehicle registrations by State. Its most recent statistical report shows a total of 176.2 million motor vehicles of all types, of which 77 percent were automobiles, 0.3 percent were buses, and about 23 percent were trucks.[2] The number of commercial and private truck-tractor registrations declined by over 20 percent between 1979 and 1986. Selected registration figures are presented in table 2-1 for 1979-1986. Light trucks—pickups, panel trucks, and delivery vans, generally of 13,000 pounds or less gross vehicle weight (GVW)—dominate the population of registered trucks, making up 83 percent of

Table 2-1.—Total U.S. Truck and Bus Registrations, 1979-86[a] (in millions)

Year	Total State motor vehicle registration—all vehicles	Total truck registrations[b]	Total commercial and private truck-tractor registrations	Private and commercial trailers	Total commercial bus registrations
1986	176.2	40.2	1.1	3.4	0.11
1985	171.7	39.0	1.2	3.4	0.11
1984	166.5	38.0	1.1	3.2	0.11
1983	163.9	36.5	1.2	3.1	0.11
1982	159.5	35.3	1.2	3.2	0.11
1981	158.5	34.5	1.2	3.0	0.10
1980	157.3	33.6	1.4	3.3	0.10
1979	153.6	33.3	1.4	3.3	0.10

[a] Data have some limitations, such as possible double counting for multiple registrations and reporting lag times of 16-18 months. Data are compiled by States and are supplemented by the Federal Highway Administration to reduce double counting.
[b] Predominantly light trucks (included 36 million pickup trucks in 1986).

SOURCE: Federal Highway Administration, *Highway Statistics* (Washington, DC: U.S. Department of Transportation, 1979-86).

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[2] Federal Highway Administration, *Highway Statistics—1986* (Washington, DC: U.S. Department of Transportation, 1986).

the 40.2 million truck fleet. Only 1.1 million truck-tractor power units and 3.4 million commercial-type trailers and semitrailers were counted in 1986.

The Bureau of the Census has conducted surveys roughly every 5 years of various transportation activities including a Truck Inventory and Use Survey (TIUS) as part of the Census of Transportation.[3] The TIUS is currently underway, and while data from the 1982 TIUS are somewhat outdated, they are the most recent available.

Heavy Trucks

Most heavy commercial trucks travel close to 100,000 miles per year and dominate commercial interstate traffic. The small trucks and vans that comprise the vast majority of truck sales play only a minor role in interstate commerce. Figure 2-1 presents a selection of heavy truck types in silhouette, and illustrates the diversity of commercial vehicles in use on our highways. Many heavy commercial trucks employ a tractor-trailer configuration, as reflected by all but one of the truck types shown, although numerous straight trucks and dump trucks are also included in this category.

The definition of a heavy truck varies for regulatory and legislative applications by the various State and Federal authorities concerned with motor carriers. Most industry observers categorize trucks by weight rather than by actual size, because heavy trucks pose special engineering problems (mainly high axle and wheel loadings that stress the roadway) and safety hazards. Federal statute suggests one definition, because the Federal Government imposes a heavy vehicle use tax on vehicles that exceed 26,000 pounds GVW, and most loaded vehicles operating in interstate commerce exceed that level.

Total truck sales numbered 3.8 million in 1987. Trucks are categorized by various weight classes, and the two heaviest are Class 7 (26,001 to 33,000 pounds) and Class 8 (33,001 pounds and over). Two relatively comprehensive sources provide data on these trucks. First, the Motor Vehicle Manufacturers Association (MVMA) reports on retail sales of trucks by weight class—selected MVMA data are presented in table 2-2. Sales of the heaviest class have fluctuated substantially over the past few years, reflecting business conditions and regulatory changes. After a slump in sales of heavy trucks in 1986, sales rebounded in 1987 and 1988, reflecting fleet renewals with more fuel efficient, durable vehicles.

A trucking industry profile presents more detailed data on trucks owned and operated by commercial enterprises (see table 2-3). Over 1.8 million trucks of Classes 6 (19,501 to 26,000 pounds), 7, and 8 were operated by more than 343,000 commercial enterprises in 1986. Just over 1 million Class 7 and 8 trucks are operated by about 180,000 businesses. Table 2-3 also shows two other descriptive classifications for users of Classes 7 and 8, by type of enterprise and by fleet size. Vehicles used in the "trucking" business are classified as "for hire," while trucks used to transport company-owned goods as part of an overall commercial enterprise are classified as "private." About two-thirds, or over 681,000, of the heaviest vehicles are classified as private and are operated by over 81 percent of the companies owning large trucks. The remaining one-third of the heavy truck fleet is for-hire. Private and for-hire fleets own roughly equal numbers of tractor-trailer combinations. In general, however, companies whose primary business is to provide trucking services for hire operate only about one-third of the largest trucks.

Over 84 percent of the establishments that operate Class 7 and 8 trucks own fleets of only one to five large trucks; thus a high proportion of small enterprises operate the largest trucks. A few large companies with fleets of 100 or more vehicles own nearly 40 percent of the Nation's Class 7 and 8 trucks, yet constitute only 0.4 percent of all trucking companies. These large firms include the major national for-hire trucking companies, the large private carriers, and the few large specialized carriers.

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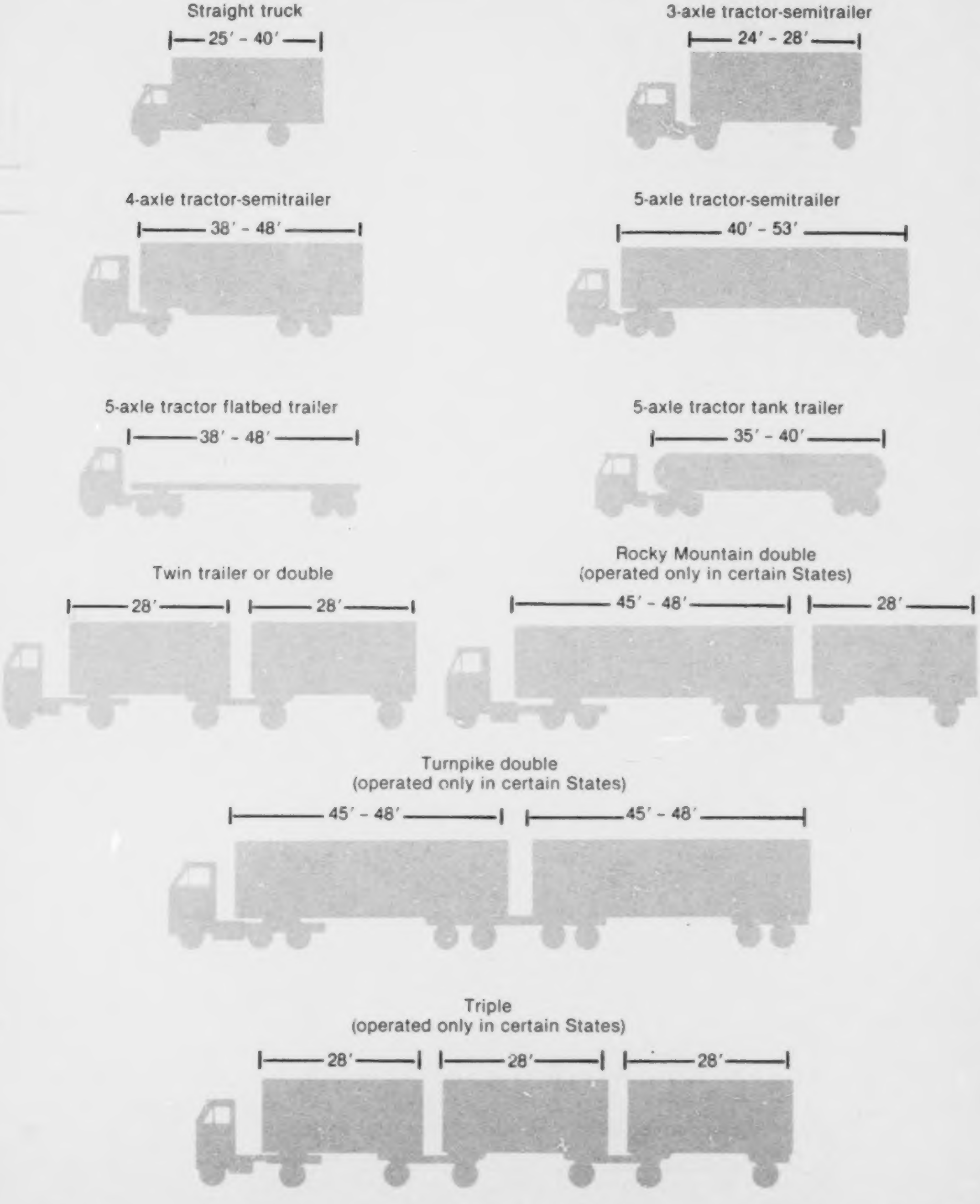
[3] U.S. Department of Commerce, Bureau of the Census, *Truck Inventory and Use Survey* (Washington, DC: various years).

Figure 2-1.—Truck Types



Straight truck

3-axle tractor-semitrailer

4-axle tractor-semitrailer

5-axle tractor-semitrailer

5-axle tractor flatbed trailer

5-axle tractor tank trailer

Twin trailer or double

Rocky Mountain double
(operated only in certain States)

Turnpike double
(operated only in certain States)

Triple
(operated only in certain States)

Lengths shown are typical; shorter or longer lengths are possible depending on carriers' needs and State laws.

SOURCE: Office of Technology Assessment, 1988; based on American Trucking Associations.

Table 2-2.—New Truck Sales (by gross vehicle weight, in pounds)

Year	6,000 and less	6,001-10,000	10,001-14,000	14,001-16,000	16,001-19,500	19,501-26,000	26,001-33,000	33,001 and over	Total
1978	1,231,559	1,990,547	74,938	5,989	5,476	178,992	41,151	177,587	3,706,239
1979	1,014,016	1,594,060	19,163	2,399	4,611	163,304	46,264	192,889	3,036,706
1980	592,339	794,184	5,661	362	2,946	91,119	58,846	121,826	1,667,283
1981	629,030	816,373	311	591	2,764	85,000	52,264	114,575	1,700,908
1982	917,908	803,639	280	58	1,556	47,330	58,498	77,186	1,906,455
1983	1,370,395	849,498	223	2	1,252	47,848	59,026	85,653	2,413,897
1984	1,707,301	1,061,974	1,631	4	5,713	60,457	87,396	150,849	3,075,325
1985	1,988,434	1,057,556	19,463	0	5,345	53,471	98,406	134,230	3,356,905
1986	2,130,874	997,272	0	0	5,931	45,333	96,998	116,477	3,392,885
1987	2,475,402	1,052,958	0	366	6,085	46,473	103,188	136,938	3,821,410

SOURCE: Motor Vehicle Manufacturers Association, *Facts & Figures (1978-1987)*.

Table 2-3.—Number of Trucks Owned and Operated by Commercial Enterprises, Selected Data for Largest Weight Classes, 1986

Commercial Truck Ownership for Largest Weight Classes		
	Number of companies	Number of trucks
Classes 6, 7, and 8[a]	343,176	1,806,488
Class 6 only	259,691	785,698
Class 7 and 8: (by company type)		
private	151,326	681,153
for-hire	28,651	339,637

Fleet Size for Companies Operating Class 7 and 8 Trucks		
Fleet size	Number of companies	Percent of companies
1-5	151,455	84.2%
6-10	15,379	8.5%
11-25	8,855	4.9%
26-50	2,523	1.4%
51-100	1,004	0.6%
100 or more	761	0.4%

[a] Standard designations for truck weight classes are expressed in gross vehicle weight as follows: Class 6 is 19,501 to 26,000 pounds; Class 7 is 26,001 to 33,000 pounds; Class 8 is 33,001 pounds and over.

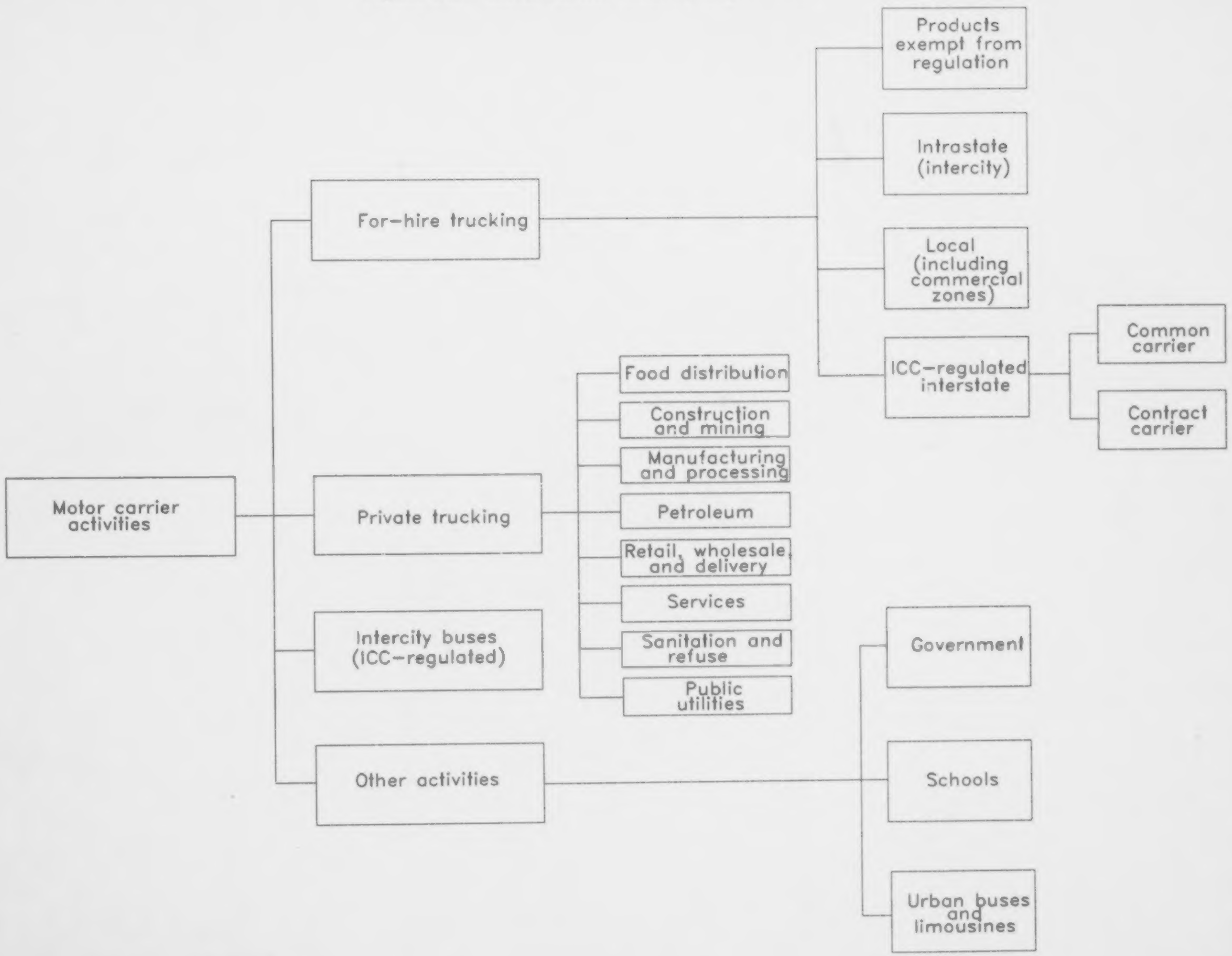
SOURCE: Dun & Bradstreet Marketing Service, *Profile of the Commercial Heavy Truck Market: An Industry Update* (compiled from Trinc Transportation Consultants database) (W. Newport Beach, CA: Newport Publications, 1986).

INDUSTRY CHARACTERISTICS

Trucking is a service activity comprising many varied market segments, with the two broadest categories defined as 1) private and 2) for-hire carriers. Private carriers transport their own freight as an adjunct to their basic business and are not always considered in discussions of the trucking industry. A local baker using a delivery truck is engaged in private carriage, and so is a national chain, such as Sears, when it distributes goods in its own trucks. For-hire carriers are always considered trucking companies and are engaged to haul freight belonging to another party. For-hire carriers are subject to Federal and State economic regulations, while private carriers are normally exempt from most of those economic regulations.

Figure 2-2 portrays the traditional division of the key types of trucking companies by primary market orientation. Changes in trucking laws and regulatory approach have blurred some of the distinctions, but the categories remain basically valid because most trucking businesses have a market specialty. However, since deregulation, a truck normally engaged in private carriage may be operated for hire under certain circumstances. Similarly, a truck may carry products exempt from regulation, then later

Figure 2-2.—Motor Carrier Industry Organization


Motor carrier activities
For-hire trucking
Private trucking
Intercity buses (ICC-regulated)
Other activities
Products exempt from regulation
Intrastate (intercity)
Local (including commercial zones)
ICC-regulated interstate
Common carrier
Contract carrier
Food distribution
Construction and mining
Manufacturing and processing
Petroleum
Retail, wholesale, and delivery
Services
Sanitation and refuse
Public utilities
Government
Schools
Urban buses and limousines

KEY: ICC = Interstate Commerce Commission.
SOURCE: Office of Technology Assessment, 1988.

be leased to a carrier that has interstate authority to carry regulated commodities.

ICC-Regulated Carriers

Carriers operating for hire in interstate commerce generally require Interstate Commerce Commission (ICC) authority and are subject to Federal economic regulations related to markets and commodities served, tariff filing, and financial responsibility. Regulated interstate for-hire carriers may operate as common carriers or as contract carriers. Common carriers are expected to provide authorized movements to any shipper requesting service according to publicly available tariffs (price lists). Contract carriers may provide services to shippers with whom they have a written contractual agreement, which normally includes service and volume commitments and a schedule of charges. With the appropriate ICC authority, carriers may function both as common carriers and as contract carriers.

Interstate transport refers to product movements whose origin and destination are in different States, whereas *intrastate* shipments have both origin and destination within a single State. Interstate movements by for-hire carriers may be carried in all types of equipment, but long-distance, high-volume shipments generally move in tractor-trailer combinations.

Intrastate (Intercity)

Shipments carried for hire between two points within a State are not subject to ICC economic regulation. However, the majority of States impose economic regulations governing certification (entry), tariffs, and other requirements on intrastate motor carriers. The intensity of regulation varies by State; two States have never imposed economic regulations on truckers, and several States, Arizona and Florida for example, have completely deregulated intrastate trucking. Carriers may operate both intrastate and interstate, if properly authorized. Very few data exist regarding the operating practices and financial health of intrastate carriers.

Intrastate (Local)

Local movement of goods for hire are usually not subject to either State or Federal economic regulations if both origin and destination are within the same locale. Information about local trucking is limited; much local movement is private in nature, and no comprehensive data exist about local for-hire trucking. ICC has stipulated areas surrounding jurisdictions, termed "commercial zones," in which ICC regulations do not apply, even if the movement is interstate in nature. The geographic coverage of these commercial zone exemptions has been expanded over time, and further revisions are currently being considered. Until recently, the Department of Transportation (DOT) safety regulations exempted movements within commercial zones from some safety requirements, although a different definition of commercial zone was used for safety. After substantial evidence accumulated of a high number of safety violations among carriers in commercial zones, Congress began to consider legislation to eliminate these exemptions to safety regulations. DOT issued a rule in May 1988, ending the exemptions in November 1988.

Exempt Movements

Several significant segments of interstate trucking are exempt from ICC economic regulations—for example, carriers transporting such commodities as unprocessed agricultural products, livestock, periodicals, decorative stone, and wood chips. This group of carriers typically specializes in exempt agricultural produce and seasonally shifts trucking operations from one producing region to the next. They are not required to conform to the entry or pricing requirements applied to other interstate for-hire carriers.

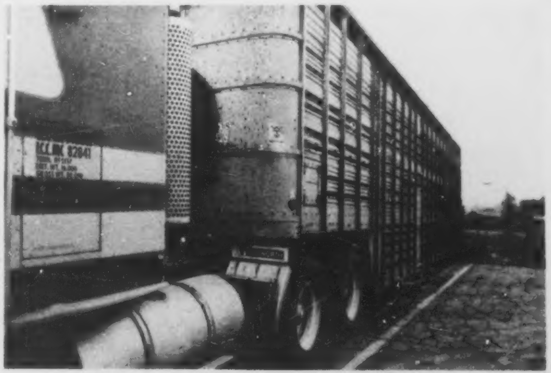


Photo credit: Land Line

Although livestock carriers are exempt from ICC economic regulations, many must comply with Federal safety regulations.

However, the exemption from economic regulation is dependent on the commodity being hauled, not the nature of the carrier organization or equipment. These carriers must still comply with DOT safety regulations and insurance requirements (if interstate carriers) and with various State trucking laws.

Private Carriers

A large number of manufacturers, distributors, wholesalers, and retailers operate private (not for hire) trucking fleets as an adjunct to their regular business activities. These private fleets are a substitute for, and compete indirectly with, for-hire trucking services. Private fleet operators value their control over service, schedules, and equipment. In the 1980s, some corporate managements began to scrutinize traffic management and private fleet operations more closely as "profit centers."

Private fleets vary from large trucking operations of Fortune 500 firms to small one or two truck fleets used to transport goods to and from vendors and customers. These fleets dominate the portion of the carrier industry using heavy straight trucks. Smaller trucks in private fleets are apt to serve mixed purposes beyond freight movement. For example, a van or pickup truck may be used for commuting or to make sales calls. Very little aggregate data is available on the operating practices or financial conditions of private carriers.

Trucks operating as private carriers are not subject to ICC economic regulation. However, private carriers are now permitted to offer certain intercorporate and for-hire services with ICC approval. Private carriers are subject to DOT safety regulations and to various State trucking laws.

State Requirements for Truckers

Every State has its own set of requirements for truckers engaged in freight movements, whether the movements are intrastate or interstate in nature. Historically, Federal policy has left many aspects of trucking under State jurisdiction. Each State may impose its own requirements in at least six areas, and these requirements often overlap and differ from the requirements of other States and the Federal Government.

Vehicle Registration

Motor vehicles, including trucks, are generally required to be registered in the State of owner residence. Registration provides for vehicle identification plates (license plates) and ownership verification (title), and generates a registration fee to the home State. Commercial trucks crossing State lines encounter a variety of different registration requirements, and cannot assume reciprocity treatment as is the case for automobiles.

Fuel Taxes

Each State may impose its own fuel tax, and such taxes represent an important source of State revenue. States generally have sought to devise collection methods that are not dependent on location of fuel purchase, but reflect fuel used and/or mileage traveled within the State by large commercial trucks. However, State requirements for the payment of fuel taxes differ substantially.

Other Taxes

A number of States impose taxes on interstate motor carriers in addition to or in place of registration fees and fuel taxes, commonly called third-structure taxes. Third-structure taxes are usually truck-mileage taxes that may also increase with vehicle weight. These taxes are based on the finding that heavy trucks create wear and maintenance costs for the highway system that increase more than proportionately with fuel used. Eleven States imposed third-structure taxes in 1987.[4]

Economic Regulations

Most States place economic requirements on intrastate freight movement; many still require carriers to file for rate increases. Carriers must seek certification to operate under various State laws governing the public convenience and necessity of their services. Safety and insurance requirements are often incorporated in these State regulations.

Size and Weight

States have their own size and weight restrictions that apply to State and local roads not on the designated map of the National Truck Network (including the Interstate system and other specified routes). Indeed, no Federal size and weight statutes existed prior to the 1956 designation of the limited-access Interstate system. States often evaluate road conditions and route configurations as suitable for vehicles smaller in size and lighter in weight than those now allowed by Federal law. This has raised many issues about the access of large, heavy vehicles to commercial locations in a State. (See chapters 3 and 5 for further details.)

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[4] American Trucking Associations, Department of State Laws, "State Taxes," unpublished manuscript, January 1987.

Hazardous Cargo

Each State has concerns about hazardous cargo moving within and through the State, and a variety of State laws to regulate these movements. To qualify for Federal motor carrier safety program funds, States must adopt Federal hazardous materials regulations or similar ones and apply them to intrastate transport. Local governments have also become increasingly active in regulating the movement of hazardous cargo.

Other Industry Characteristics

Equipment Type

Equipment type varies for each form of carriage, and with market conditions, cost considerations, and fleet available. The conventional combination truck in interstate service is a tractor pulling a 45- to 48-foot dry van trailer or twin 28-foot trailers. Certain Western States allow triple 28-foot trailers and a few Western and Northeastern States permit longer combinations (such as twin 45-foot trailers) on designated highways, often requiring the carrier to obtain a special permit. All States allow oversized vehicles if a special permit is obtained, although most States will grant overweight permits only for nondivisible loads. Among the many other specialized trailer types are tank trailers, flatbed trailers, refrigerated trailers, automobile rack trailers, hopper trailers for grains and ores, pole trailers, and a variety of special-purpose trailers. Trailers are not normally dedicated to run in combination with a particular tractor or driver.

Equipment Ownership

Truck-tractors, trailers, and other carrier equipment may be owned by the carrier or leased from other sources. Equipment may be leased, with or without drivers, from truck leasing firms, from a separate for-hire or private carrier, or from an independent owner-operator. Each of these sources may provide one or more trucks on a permanent lease for a period of time and/or for a trip-lease for the duration of the trip. Responsibility for maintenance services varies considerably from one lease to another. The variety of ownership and leasing arrangements has grown considerably over recent years. Enforcement of safety and other requirements becomes more complex when the truck owner differs from the company using and/or driver operating the truck.

Owner-Operators

Owner-operators are independent trucking contractors who offer their services to a variety of customers. These small operators may haul exempt commodities, work for certificated carriers under lease arrangements, or transport regulated commodities under their own ICC operating authority.

About 80 percent of all owner-operators own and drive just one truck[5] and often have no fixed place of business, no maintenance shop, and very limited capital. The remaining 20 percent of independent truckers operate small fleets of up to 20 trucks and hire other drivers, even though they continue to think of themselves as owner-operators. About 75 percent of all owner-operators are leased to ICC-regulated carriers and private carriers, and about 25 percent haul exempt commodities. A 1986 survey of more than 5,300 independent truckers found that over 78 percent surveyed owned their power units or tractors, while only 26 percent owned trailers.[6]

Prior to regulatory reform in 1980, owner-operators typically did not possess ICC operating authority, and were not directly regulated by ICC. Over the past 8 years, many owner-operators have obtained ICC interstate authority for moving regulated commodities, comprising a major part of the

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[5] James Johnston, Owner-Operators Independent Drivers Association of America, testimony before the Senate Committee on Commerce, Science, and Transportation, Oversight Hearing on the Motor Carrier Act of 1980, September 1985.

[6] *Road King*, "Drivers' Opinion Survey VI," sponsored by Associates Commercial Corp. and Unocal, unpublished manuscript, June 6, 1986.

Photo credit: Tse-Sung Wu, OTA staff

Owner-operators often have their cabs equipped with sleeping berths that become the driver's home away from home.

dramatic increase in the number of ICC-regulated carriers.

Several studies in the last two decades have attempted to estimate the total number of owner-operators and to assess their financial and operating results. Because data are imprecise, these studies have produced quite different results and a wide range of estimates. Most industry observers believe that a substantial number of independent truckers have left the industry in recent years as a result of competitive pressures leading to long and arduous working hours. Various sources indicate that at least 100,000 owner-operators remain in business.[7]

Union Representation

The trucking industry has a long history of union representation. The International Brotherhood of Teamsters (IBT) is the major union representing the for-hire segment of the industry, although the unionized labor force has shrunk with the decline of the general freight, common carrier segment of the business. Slightly less than half of all truckload carriers and other parts of the trucking industry that rely on independent owner-operators employ union drivers. Private carriers, if organized, employ members of other unions as well as IBT members. Since the Motor Carrier Act of 1980, new entrants have used predominantly nonunion drivers.

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[7] Marshall Seigel, Independent Truck Owner-Operators Association, testimony before the Senate Committee on Commerce, Science, and Transportation, Oversight Hearing on the Motor Carrier Act of 1980, Sept. 21, 1983.

THE NATION'S BUSES

The bus industry is the passenger-carrying segment of the motor carrier industry. Buses were not major passenger carriers even in their prime, and were hit hard by increased automobile ownership and use, competition from subsidized passenger rail, and deregulation of the airlines in 1978. Competition among air carriers for intercity travel brought lower air fares that have proven a major attraction for price-sensitive passengers on long distance trips.

The bus industry has several clearly defined major segments. One large group provides intercity and interstate regular passenger route service under ICC regulation, and several other segments provide other important passenger services. These include charter operators, who offer group and tour service, school bus operators (both school district and contract service), and local transit agencies.

The intercity bus industry includes large and small carriers and a few very large, Class I carriers (see table 2-4). Industry-wide data are difficult to obtain, because regulatory changes have reduced bus company reporting requirements. The bus industry has declined nationwide over the last 10 years—bus-miles, passengers-carried, and employee numbers all trend downward, and total operating revenues have declined since the early 1980s. For Class I carriers the decline is more striking, with the number of bus passengers declining 37.5 percent between 1980 and 1986.

The largest interstate bus companies have suffered the most severe financial reverses. Greyhound, by far the biggest bus operator, with 6,800 drivers for 3,500 buses, took over the nearly-bankrupt Trailways operation in late 1987. Both carriers had regularly reported operating losses in recent years; those losses widened in early 1987, triggering their merger.

Bus Deregulation in 1982

Competition from other travel modes continued after regulatory reform for interstate buses in 1982 brought needed flexibility for bus operators. Because bus ridership had declined significantly, major national operators considered the right to withdraw

Table 2-4.—Intercity Bus Industry in the United States
(including operations of all carriers reporting to the Interstate Commerce Commision and intrastate carriers)

	1970	1975	1980	1985	1986
Number of companies	1,000	950	1,330	NA	NA
Number of buses	22,000	20,500	21,400	20,100	19,100
Number of employees	49,500	46,600	49,100	43,300	40,600
Total bus-miles (millions)	1,209	1,120	1,162	997	945
Revenue passengers (millions)	401	354	365	353	346
Revenue passenger-miles (millions)	25,300	25,600	27,400	23,800	22,500
Operating revenues, all services ($ millions)	901	1,165	1,943	1,898	1,838
Operating expenses ($ millions)	812	1,098	1,811	1,839	1,781
Net operating revenue, before income taxes ($ millions)	89	68	132	59	57
Class I interstate carriers only (over $5 million annual revenue)	1970	1975	1980	1985	1986
Number of companies	71	84	46	43	29
Number of buses	10,158	9,800	8,427	7,240	6,230
Number of employees	34,383	35,140	30,950	24,210	21,090
Total bus-miles (millions)	871	849	771	580	524
Revenue passengers (millions)	174	152	132	91	83
Revenue passenger-miles (millions)	17,900	18,200	17,080	12,510	11,117
Operating revenues, all services ($ millions)	722	955	1,390	1,270	1,168
Operating expenses ($ millions)	639	893	1,311	1,212	1,115
Net operating revenue, before income taxes ($ millions)	83	62	79	58	53
Operating ratio	89	94	94	95	95

SOURCE: American Bus Association and Interstate Commerce Commission data.

Photo credit: California Department of Transportation

The intercity bus industry has faced fierce competition for passengers from private automobiles, low cost air travel, and Amtrak.

from markets, not entry, as the key regulatory issue. States, in particular had resisted discontinuing bus services, and Congress found that: "State regulation of the motor bus industry has, in certain circumstances, unreasonably burdened interstate commerce. . . ."[8] Permitting smaller, regional carriers to provide low-cost service was also projected as a benefit of regulatory reform.

Safety Aspects

The number of buses operating on the highways is so much smaller than the number of trucks that bus accidents do not figure prominently in national accident data. However, because passengers are involved, the safety record of the bus industry is highly visible, and buses are subject to broad State controls. Interstate operators encounter numerous complex and conflicting State requirements and could benefit from more uniform treatment at the State level.

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[8] Bus Regulatory Reform Act of 1982, Public Law 97-261, Sec. 3.

At the initiative of the American Bus Association, the major intercity bus industry representative, the industry has recommended additional Federal safety regulations for interstate buses, including extension of coverage for Federal safety provisions to private and not-for-hire bus operators. Proposed legislation calls for the establishment of an office of bus safety in FHWA, and would impose relatively uniform Federal requirements on motor carriers of passengers.

FORCES FOR ECONOMIC CHANGE IN TRUCKING

Several powerful forces have changed the trucking industry, including regulatory evolution, legislative mandates, and shifts in economic structure. This section briefly highlights these forces, focusing on developments over the past decade.

Regulatory Shifts

Interstate for-hire trucking is and has been for years subject to regulation by ICC. In earlier years, entry, markets served, and rates were subject to detailed ICC examination and control through a complex approval/disapproval process, which came under severe criticism during the 1970s. ICC began to shift away from many regulatory strictures, especially after Presidents Ford and Carter strongly urged less regulation and made their Commission appointments accordingly. ICC interpretations became significantly less restrictive in the years just prior to 1980. Operating permits (authority to engage in interstate transportation) became much easier to obtain and collective rate-making practices by interstate motor carriers were reviewed. These ICC actions were controversial and stimulated congressional hearings and eventual passage of motor carrier legislation in 1980.

Motor Carrier Act of 1980

The Motor Carrier Act of 1980 (MCA) represented the first major change in the statutes since 1935 and has profoundly influenced the interstate motor carrier industry by significantly altering the ICC regulatory framework. Like most major legislation, the MCA reflected years of hearings, several Administration proposals, and extensive committee deliberations. Congress found, as stated in the act, that the motor carrier regulatory statutes were outdated and required revision. The intent of the act was to reduce unnecessary regulation and to provide explicit direction to ICC, which had been deregulating independently.

Key areas of change for the federally regulated segment include reduced requirements for new entrants, fewer restrictions on expansion by existing firms, and greater pricing freedom. However, interstate motor carriers remain subject to ICC regulation, although in a much relaxed framework.

Surface Transportation Assistance Act of 1982

The Surface Transportation Assistance Act of 1982 (STAA), omnibus highway and transit authorizing legislation, contained provisions affecting truckers in two important economic areas, motor carrier user taxes and truck size and weight. Under the STAA, fuel taxes were increased sharply to 9 cents per gallon, from the 4-cent level that had been in effect since 1959. Moreover, the STAA enacted increases in the heavy vehicle use tax applicable to vehicles exceeding 26,000 pounds GVW. After much controversy over the heavy vehicle tax, a differential of 6 cents per gallon additional tax on diesel fuel was enacted, and the heavy vehicle use tax was rolled back. Thus, diesel trucks experienced a fuel tax increase from 4 to 15 cents per gallon in mid-1984.

In 1956, Federal law restricted vehicles using the Interstate system to 73,280 pounds, but Federal legislation passed in 1974 permitted States to raise truck weights. As a trade-off to industry for higher fuel taxes, truck size and weight restrictions were amended in 1982 and 1983 to permit larger, heavier trucks to use the Interstate system. The STAA mandated that States allow trucks with gross weights up to 80,000 pounds to use the Interstate system, overriding lower, more restrictive weight limits in several States. The 1982 act also initiated Federal length limitations for commercial vehicles; States now cannot limit semitrailer lengths to less than 48 feet nor second-trailers in combination units to less than 28 feet. In 1983 Federal legislation prohibited States from restricting truck width below 102 inches (up from 96 inches) on the Interstate system.

The 1982 act further limited State laws by providing that no State could deny "reasonable access" for large trucks to reach terminals and other facilities from the Interstate network. That is, States must allow large, heavy trucks not only to use the Interstate but also to get on and off the Interstate and use State roads.

The Surface Transportation and Uniform Relocation Act of 1987

This 1987 legislation provided funding for Federal-aid projects over the next 5 years and extended user taxes at current levels. No major provisions affecting motor carriers or changing their treatment were incorporated.

Other Forces for Change

Legislative and regulatory actions are an important force affecting the trucking industry, yet they are but one component of the business environment. Other economic aspects of trucking operations are briefly outlined below.

- **Energy Costs**. Fuel prices shot upward in the late 1970s, but have declined and stabilized in recent years. Diesel fuel used by most combination trucks more than doubled in price between 1978 and 1981, and in 1986 remained about 73 percent higher than 1978 including the higher Federal and State taxes.[9]
- **Inventory Policies**. Many companies have adopted "just-in-time" inventory policies, spurred on by high interest rates and a need to reduce carrying costs, putting a premium on service quality and reliability. Pressure for on-time deliveries has increased, and for-hire trucking companies have responded by stressing service, including reliable deliveries.
- **Import Growth**. Imports of manufacturer and consumer goods have grown phenomenally, while domestic production levels have been disappointing. This changes the market orientation for trucking services and equipment. Container traffic has grown rapidly, originating at ports and major rail hubs.
- **Insurance Crisis**. The cost of insurance for motor carriers rose rapidly in the mid-1980s and availability of insurance coverage became a problem. Insurance costs are a small percentage of total operating costs, but that percentage almost doubled between 1984 and 1986, to reach 3.6 percent.[10]
- **Highway Conditions**. Traffic growth over the past decade outpaced highway improvements. In fact, completion of the Interstate system, originally planned for 1969, has just now become a possibility with the funding provided by the 1987 act. As a result of inflation and funding constraints in the late-1970s and early-1980s, highway pavement conditions deteriorated and volume/capacity ratios increased. Poor pavement and heavy congestion pose special problems for the operation of large trucks.[11] Increased Federal aid in the mid-1980s brought some improvements.

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[9] American Trucking Associations, *American Trucking Trends, 1987* (Alexandria, VA: 1987), p. 44.

[10] Ibid., p. 28.

[11] Federal Highway Administration, *Status of the Nations Highways* (Washington, DC: U.S. Department of Transportation, various years).

COMPETITIVE CONDITIONS AND INDUSTRY TRENDS

Regulatory reform and economic shifts led to dramatic changes in the motor carrier industry; these changes were magnified by the recession in late-1981 and 1982. Statutory changes in user tax levels and in allowable vehicle size and weight have also led to important industry shifts.

For-Hire Carriers

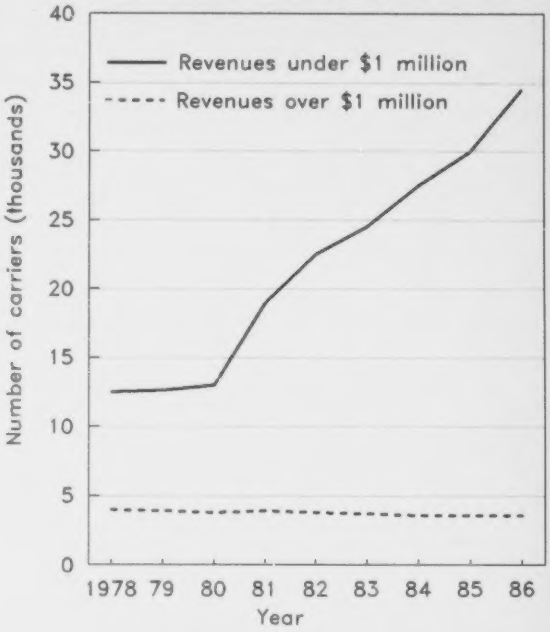
The total number of for-hire carriers rose from 67,038 in 1978 to 89,677 in 1987, a 34 percent increase.[12] The primary focus of the MCA was regulatory reform for *interstate* for-hire carriers, the group subject to Federal regulation. Easier entry was in fact accomplished, and the number of ICC-regulated carriers increased markedly in the late-1970s, then steeply in the 1980s, more than doubling to almost 37,000 in 1986 (see table 2-5).

The growth has been primarily among Class III carriers, small carriers reporting revenues less than $1 million annually. The number of Class III carriers rose from 12,900 in 1978 to 33,903 in 1986 (see figure 2-3). These numbers are dramatic, even if adjusted for company withdrawals and growth out of Class III. Meanwhile, over the same period the number of Class I and II carriers declined slightly.

State Requirements

State requirements for interstate motor carriers are gradually becoming more uniform and less burdensome. Congress encouraged this process through provisions of Section 19 of the MCA, which required a study of State regulations and the prospects for uniformity.[13] With support from DOT, the National Governors' Association undertook a multiyear information gathering and consensus-building project that has resulted in a set of recommendations for more uniform State requirements.[14]

Figure 2-3.—Number of ICC Motor Carriers by Revenue Category, 1978-86



KEY: ICC = Interstate Commerce Commission.

SOURCE: Ronald Roth, American Trucking Associations, "Trucking: An Overview and Focus on Recent Times," unpublished manuscript, September 1987, chart 14.

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[12] Dun & Bradstreet Marketing Service, *Profile of the Commercial Heavy Truck Market: An Industry Update*, compiled from Trinc Transportation Consultants database (W. Newport Beach, CA: Newport Publications, 1986).

[13] U.S. Department of Transportation and the Interstate Commerce Commission, "Uniform State Regulations," Section 19, Report to Congress, n.d.

[14] National Governors' Association, Working Group on State Motor Carrier Procedures, *Consensus Agenda* (Ames, IA: Iowa Department of Transportation, 1986). Policy endorsing the recommendations

(continued on next page)

Table 2-5.—Number of ICC-Regulated Motor Carriers and Freight Forwarders

	Revenue classification					
Year	Class I	Class II	Class III	Other[a]	Freight forwarders	Total
1987	956	1,266	35,505	711[b]	—	38,438
1986	947	1,387	33,903	711[b]	—	36,948
1985	1,013	1,489	30,337	444	265	33,548
1984	1,088	1,554	27,370	469	261	30,742
1983	1,139	1,631	24,411	336	231	27,748
1982	1,144	2,139	22,059	380	241	25,963
1981	1,031	2,293	18,563	383	244	22,514
1980	947	2,164	14,610	324	193	18,238
1979	992	2,754	13,337	—	184	17,267

[a] Class I and Class II carriers relieved of reporting requirements.
[b] Includes freight forwarders.

SOURCE: Thomas J. Donahue, American Trucking Associations, testimony before the House Committee on Public Works and Transportation, Mar. 16, 1986.

Market Share[15]

Domestic freight volumes and the importance of trucking may be measured in several ways. Total U.S. domestic intercity freight tonnage was relatively unchanged over the period 1980-86. However, trucks increased their share from 36.5 percent in 1980 to 40.1 percent in 1986, after some declines in the late-1970s when railroads successfully captured growth in heavy freight such as coal. Domestic intercity ton-miles reflect both weight and distance moved; in 1986 intercity ton-miles exceeded 1980 levels for the first time since sharp declines in 1981 and 1982. Trucking increased its share of intercity ton-miles from 22.3 percent in 1980 to 25.3 percent in 1986.

Trucks have traditionally carried high-value freight over shorter distances than rail and earned higher than average freight tariffs per ton-mile. In contrast, railroads carry large amounts of low-rated heavy bulk commodities such as sand, gravel, and coal. Thus, trucking revenues comprise 76 percent of all intercity freight revenues, a percentage that has gradually increased since 1980. While deregulation of both railroads and trucking occurred in 1980, motor carriers have continued to increase market share, although at a slower rate. Many motor carriers now use their fleets very productively and at low unit costs. Moreover, truck service characteristics are well-suited to the growing use of light density, high value components and the decline in traditional heavy manufacturing. Intermodal traffic is growing, and trucks play an indispensible role in it. Goods move by rail over high-density routes in double-stack containers from U.S. ports to inland intermodal transfer terminals, where distribution is completed by truck.

Market Competition

The amount of actual and potential competition in individual markets has grown to a much greater extent than indicated by the number of certificated carriers. The authority conferred by ICC to transport interstate freight is now much broader and has fewer restrictions limiting points served, commodities carried, or routes used. It has become commonplace for ICC to grant motor carrier authority to serve all points in the United States for general commodities, whether or not the carrier has applied for the broad authority.

Profit Margins and Overcapacity

The motor carrier industry has continued to gain market share over the past 10 years, but profits have been elusive for many firms in the face of an increasingly competitive transportation marketplace. Regulatory reforms eased entry and permitted better capacity utilization for some carriers, while the 1981-82 recession damped factory production and shipment levels.

However, the issue of capacity is complex. The number of tractor-trailers on the road dropped over 1 percent, and the number of single-unit trucks declined 8 percent between 1980 and 1986. At the same time truck tonnage increased almost 11 percent.

Truck-miles traveled increased nearly 30 percent per vehicle, and trailer capacity increased as wider and longer vehicles were allowed. Thus, each truck is dispatched more frequently, spends more time traveling, and carries more. Moreover, carriers seeking backhauls offer very low rates rather than return empty, so that capacity is frequently readily available at low cost. The amount of freight carried in each average truckload has remained constant (13.6 tons in 1980, declining to 13.3 in 1986). These facts all imply that despite the drop in the number of trucks, substantial unutilized trailer capacity has remained available.[16]

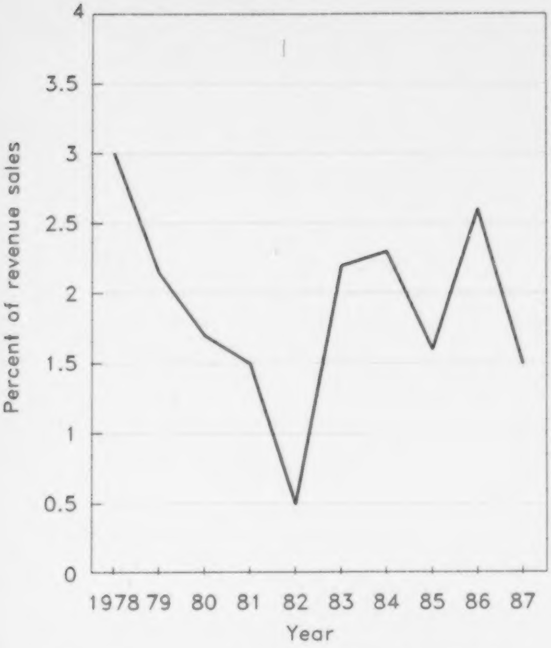
The result has been higher operating ratios (ratio of operating expenses to revenues) on average, including sharp rises in operating ratios from 1978 through 1982, followed by modest, uneven improvements in the mid-1980s. Profit margins measuring net income as a percent of sales show deterioration from 1978 through 1982, followed by irregular recovery since that time until 1987 when rate cutting was severe (see figure 2-4).

(continued from previous page)
was adopted by the Governors on Feb. 26, 1986. The Working Group relied in part on the comparative information in Harrison Boyd & Associates, "Organizational Frameworks for Interstate Motor Carrier Regulation," prepared for the U.S. Department of Transportation, Federal Highway Administration, unpublished manuscript, April 1987.

[15] All domestic freight totals are from Transportation Policy Associates, *Transportation in America* (Washington, DC: 1986).

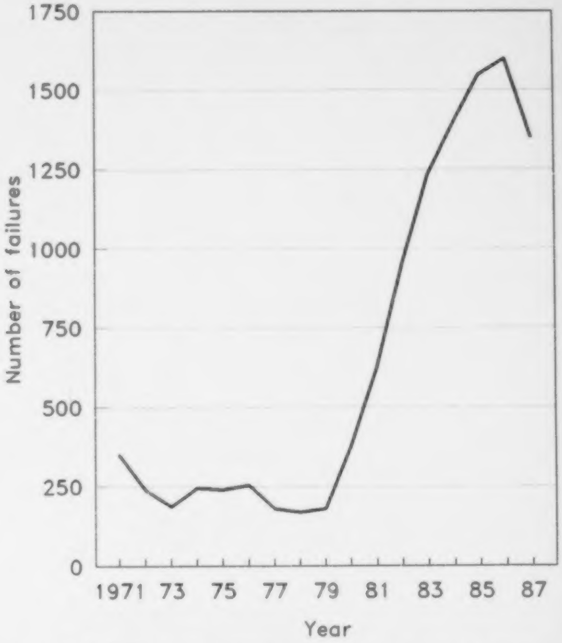
[16] Ronald D. Roth, American Trucking Associations, "Overcapacity," unpublished manuscript, July 1987.

Figure 2-4.—Net Profit Margin, 1978-87 (all carriers)



SOURCE: Ronald Roth, American Trucking Associations, "Trucking: An Overview and Focus on Recent Times," unpublished manuscript, September 1987, chart 14.

Figure 2-5.—Motor Carrier Failures, 1971-87



SOURCE: Thomas J. Donahue, American Trucking Associations, testimony before the House Committee on Public Works and Transportation, Mar. 16, 1988.

Business Failures

The intensely competitive atmosphere and continuing overcapacity in for-hire trucking is reflected in the large number of motor carrier failures. Failures for all for-hire trucking companies, including local and household, have risen dramatically from under 200 annually in 1978 and 1979 to over 1,500 in 1986. The pattern of failures between 1971 and 1987 is shown in figure 2-5. The failure rate remained high in the mid-1980s even during periods of sustained economic growth, and the number of failures showed its first decline in recent years during 1987. Even so about 150 of every 10,000 trucking companies failed in 1987, exceeding the rate of 115 failures for every 10,000 companies for all businesses.[17] Both large and small trucking companies have failed.

Heavy Truck Sales

Annual sales of heavy trucks have been relatively stagnant as shown in figure 2-6. Sales of Class 8 trucks, with gross weight capability of over 33,000 pounds, remain below the 1979 level and showed declines even in the relatively prosperous years of 1985 and 1986. Such flat sales contrast sharply with record sales levels for small trucks, pickups, and vans, which have lifted the overall truck sales market. The sales trends suggest that the increased market share and expanded number of carriers have not required growth in the number of trucking units. The median age for all trucks has increased slightly from about 6 years in 1978-1979 to 7.7 years in 1986 (see figure 2-7). Fleet purchases lowered this figure slightly in 1987.

Trailer Size

The changes in size and weight restrictions in 1982 and 1983 allowed carriers to expand capacity and

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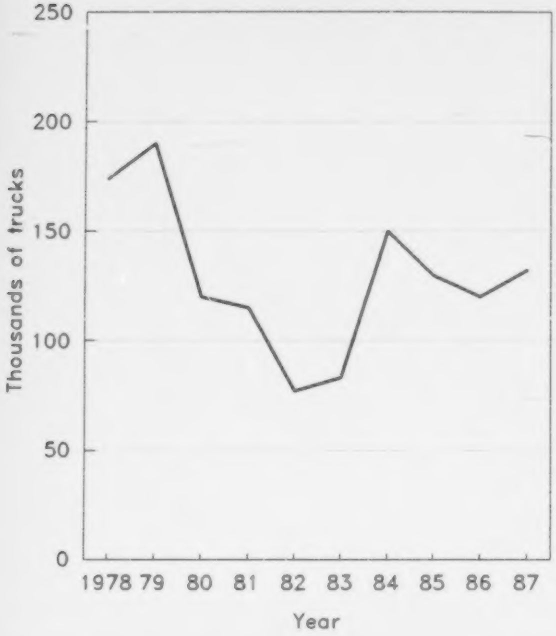
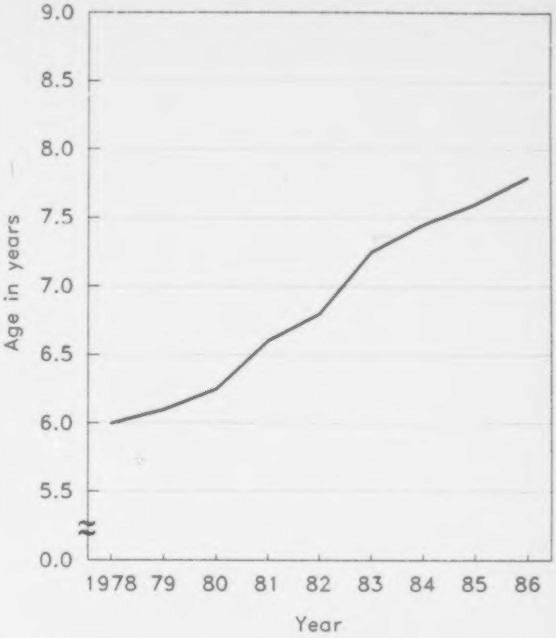
[17] Ronald D. Roth, American Trucking Associations, personal communication, July 22, 1988.

Figure 2-6.—Sales of Trucks Weighing Over 33,000 Pounds, 1978-87



SOURCE: Thomas J. Donahue, American Trucking Associations, testimony before the House Committee on Public Works and Transportation, Mar. 16, 1988.

Figure 2-7.—Median Age of Trucks, 1978-86



SOURCE: Thomas J. Donahue, American Trucking Associations, testimony before the House Committee on Public Works and Transportation, Mar. 16, 1988.

increase labor productivity—larger trailers and heavier cargo loads, where possible. Trailer producers and purchasers responded very rapidly to reconfigure the Nation's fleet of trailers. Figure 2-8 shows that 95 percent of all trailers produced in 1980 (based on samples of production shipments) were between 40 and 45 feet in length, while almost none were longer. By 1984, over 58 percent of new trailers produced were longer than 45 feet, mostly 48 feet. As of 1986, over 56 percent were over 45 feet, while 29 percent were exactly 28 feet in length, reflecting the increased use of tandem (double) trailers on the Interstate system.

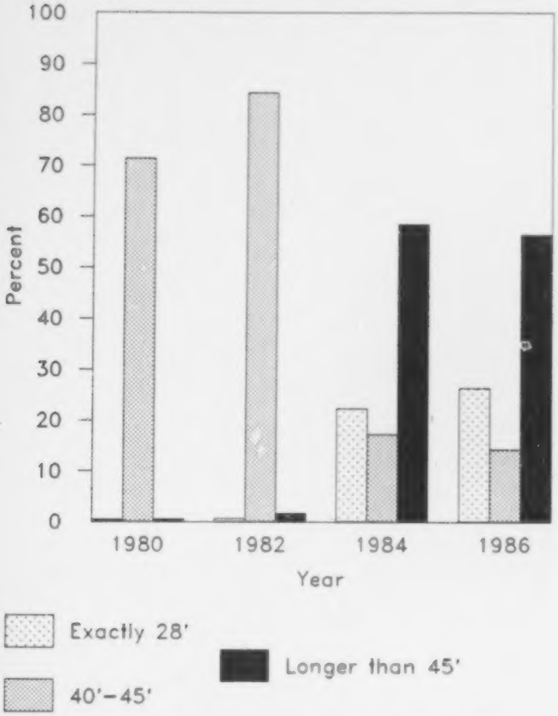
Increases in trailer width have been even more dramatic. Almost all trailers produced in 1980 and 1982 were exactly 96-inches wide, as shown in figure 2-9. In 1984, less than a year after wider trucks were permitted on the Interstate system, over 70 percent of the trailers produced were 102-inches wide or more, most exactly 102 inches. In 1986, 76 percent were 102 inches or more. The trucks encountered on our highways are indeed larger than those of just a few years ago.

Specialization and Concentration

ICC regularly reports operating results for the 100 largest regulated motor carriers; as a group, their performance has been weak, reflecting financial pressures of recent years. Data for 1981, a good year relative to the recession that followed, show that tonnage fell almost 4 percent, while net operating income declined by over 26 percent. In 1982, revenue tons hauled fell by 11 percent, operating revenues fell by 4 percent, and net operating income fell by 62 percent. Of the 100 carriers reporting, 81 showed declines in tonnage and net operating income, and the largest carriers showed a perilous aggregate operating ratio (operating expenses divided by operating revenues) of 98.7.

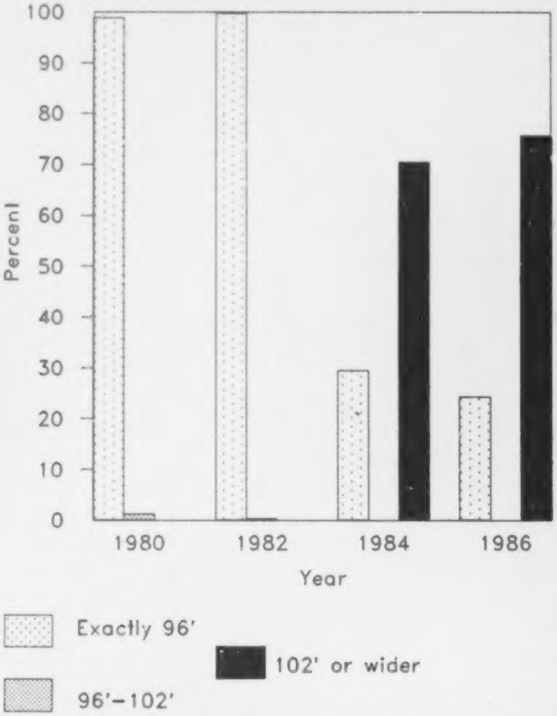
Since the recessionary period of the early 1980s, motor carrier traffic and finances have improved,

Figure 2-8.—Trailer Sales Since 1980, by Length



SOURCE: Truck Trailer Manufacturers Association, *Van Trailer Size Report*, various years.

Figure 2-9.—Trailer Sales Since 1980, by Width



SOURCE: Truck Trailer Manufacturers Association, *Van Trailer Size Report*, various years.

but not by much. In 1986, the 100 largest carriers hauled less tonnage than in 1981 but realized slightly higher net income. In 1987, tonnage increased to 181 million revenue tons, roughly the 1981 level, but profit margins were squeezed. Net income was down 48 percent, and the operating ratio reached 96.6 percent.[18]

Less-Than-Truckload Carriers

A small number of the very largest trucking companies have expanded their scope and scale of operations since 1978. The ten largest carriers, by revenue, are predominantly less-than-truckload (LTL)[19] carriers, and they have increased their share of industry revenues from about 13.5 percent in 1978 to about 16 percent in the mid-1980s.[20] The three largest carriers (excluding United Parcel Service, which dwarfs them all) are all nationwide LTL specialists: Consolidated Freightways, Roadway Express, and Yellow Freight. This Big Three is gradually capturing more traffic, showing more revenue growth, and reporting lower operating ratios relative to other large carriers on average. During the 12 months ending September 30, 1987, for example, the Big Three increased their total revenues by 5.4 percent while revenue for others in the largest 100 carriers increased an average of 3.1 percent.[21] However, size alone is not a determining factor for profits, and well-managed small LTL carriers can also do well (see box 2-A).

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[18] Interstate Commerce Commission, Bureau of Accounts, "Large Class I Motor Carriers of Property, Selected Earnings Data," unpublished data, n.d.

[19] Less-than-truckload carriers transport cargo that may come from several shippers in units that may weigh anywhere from roughly 250 pounds up to as much as 12,000 pounds.

[20] *Fortune*, "Blessings by the Truckload," Nov. 11, 1985, p. 138.

[21] Interstate Commerce Commission, op. cit., footnote 18.

Box 2-A.—A Small Less-Than-Truckload (LTL) Carrier

Numerous local and regional LTL carriers operate in special market niches despite the expansion of the large nationwide LTL carriers. One successful, high-service, relatively short-haul company markets itself as a service-oriented carrier for a specified regional market. The firm recently achieved a 99.7 percent overnight/on-time delivery record for its service territory, comprising a two-and-one-half hour driving radius around its main terminal in the mid-Atlantic area. Company drivers pull variable size trailers (no doubles are used) to haul the 700-pound average shipment handled. Continuous radio communication is maintained with drivers to ensure service reliability. Most driving is done during daylight hours, and all drivers return to the home terminal every night.

Company officials believe their good safety and service records are functions of three factors: 1) a well-functioning operating facility, housed in a single terminal; 2) reliable equipment and a preventive maintenance program; and 3) high-quality personnel. The company pays special attention to the hiring and retention of self-motivated employees, based on a belief that service to customers is only as good as company employees.

The company weathered a disruptive strike in the early 1980s and has remained nonunion since then. Management emphasizes employee relations, placing a great deal of trust in employees and using peer review committees to ensure that drivers perform effectively and safely. Driver compensation includes a base wage, plus a profit-sharing plan based on performance, including the employee's safety record.

Company employees must have a physical examination every 2 years, although the company currently does not test for drug use. The company interviews and performs background checks for each job applicant. Hiring decisions are often based on the recommendation of a current employee, and company policy is for road drivers to be brought up through the ranks. Training is provided in-house over an 8-week period. The average employee age is 37, and the average length of service is 10 years.

Established General Freight Carriers

The general freight trucking sector as a whole has been caught between rising costs and competitive pressures on rates. The Regular Common Carrier Conference (RCCC), an association with approximately 400 members, includes most of the large, established interstate common carriers. RCCC members transport general freight and earn about 80 percent of their revenues hauling LTL. According to RCCC data, more than half (53 percent) of the full service general freight carriers went out of business between 1978 and 1986.

However, truckload (TL)[22] and LTL revenues for the RCCC group differ dramatically (see figure 2-10). Revenue on LTL traffic has increased slightly, while TL revenue has decreased sharply. Tonnage carried by RCCC carriers has dropped, but again with sharp differences between categories. From 1978-86, LTL tons fell 31 percent, while TL tons plummeted 63 percent.

This established carrier group has seen its traffic erode significantly. Figure 2-11 shows that LTL-TL tonnage movements for a regularly-surveyed segment of RCCC carriers did not rebound when industrial production expanded in the mid-1980s. Presumably much of the business was captured by other carriers. Net income for 1986 was at the highest level in 10 years, but was barely above the 1978 level and has fluctuated dramatically over the period. Net income for the first 6 months of 1987 was down 61 percent compared to a year earlier.

Truckload Carriers

TL operators easily obtained operating authority in the less regulated environment of the early 1980s and grew impressively, with owner-operators providing a large portion of capacity. TL operations are simpler than LTL and do not require intermediate handling and shipment consolidation en route to make up a trailer load. Many TL carriers have minimal communications, management, sales forces, and terminal facilities. Carrier facilities are likely to be few in number, sparsely staffed, and removed

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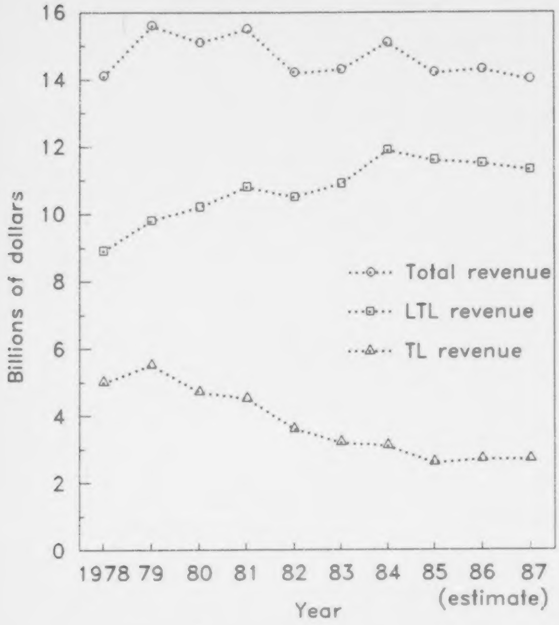
[22] Truckload carriers transport goods for a single shipper in full loads weighing from about 12,000 pounds to the legal maximum for their vehicle.

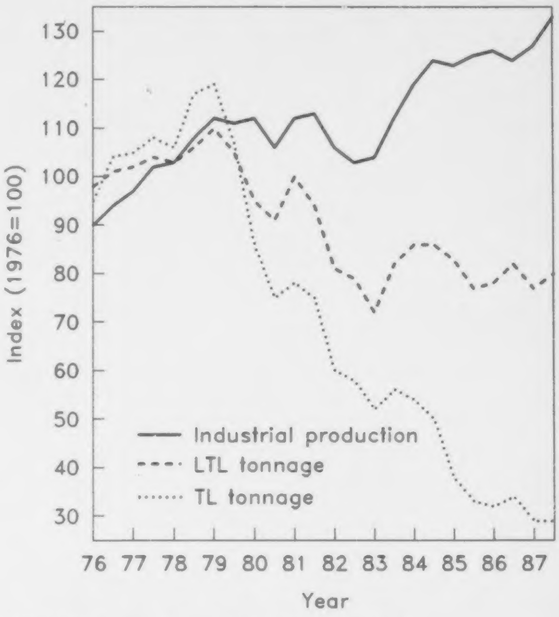
Figure 2-10.—General Freight Trucking Industry Total Revenue, 1978-87



KEY: LTL = less-than-truckload; TL = truckload.

SOURCE: Regular Common Carrier Conference, testimony of James C. Haskins before the House Committee on Public Works and Transportation, Mar. 16, 1988.

Figure 2-11.—LTL/TL Tonnage, Adjusted Seasonally



KEY: LTL = less-than-truckload; TL = truckload.

SOURCE: Regular Common Carrier Conference, "Quarterly Survey of General Freight Carrier Operating Results, 4th Quarter," 1988.

from shipment origins and destinations. However, a new operating strategy is evolving in the TL market—the high-service carrier serving targeted market niches. These TL firms provide high-capacity or special equipment and utilize their assets and labor very productively (see box 2-B). To compete successfully, many owner-operators must drive long hours and accept backhauls at low rates, circumstances creating physical, psychological, and economic hardships.

Several factors are at work to tip the balance of TL operations toward larger carriers with more capital to invest. Concerned about the reliability of leased equipment and drivers, carriers with sufficient resources buy their own equipment and employ company drivers. Many carriers, such as automobile haulers, operate highly specialized, complex equipment that is difficult to lease. Productivity is high enough that shippers pick high-service carriers for both service and unit price. Such carriers become a "core" carrier, taking a large portion of the freight from major shippers. Observers predict an acceleration of the core carrier concept.[23]

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[23] William M. Legg and John M. Larkin, "High-Service Truckload Carriers Prospering," *Industry Week*, Apr. 4, 1988, Special Supplement; and Alex Brown & Sons, Inc., "Wrap-up of the October 29 Trucking Seminar," unpublished manuscript, December 1987.

CONCLUSIONS

Trucking is a tremendously complex industry that defies easy classification. Numerous market segments are served by a variety of motor carriers, and generalizations are tenuous at best. A highly competitive market environment in the trucking industry confronts carriers of all sizes with constant financial pres-

Box 2-B.—A Truckload Carrier

One successful, medium-size truckload carrier does business in 36 States, mostly east of the Mississippi River. The company emphasizes service in its marketing strategy, and in 1986, 99.5 percent of its operations were on time or met customer service requirements. A Department of Transportation audit team reviewed the company's safety programs and rated the company satisfactory—the highest possible rating.

Safety is a company priority for both drivers and equipment. "Safety is our driving concern" is the company motto. The company recruits drivers from a list of acceptable truck driving schools, with the goal of hiring experienced drivers with good safety records. Before driving for the company, all new employees participate in a 1-week training session emphasizing safe operations and practical driving skills. New drivers are then accompanied by an experienced company driver for at least 2 weeks, and often longer. The shortage of qualified drivers and high driver turnover are two of the company's major concerns.

The firm owns approximately 246 cab-over-engine tractors and 570 trailers. Equipment is largely standardized to ease compatibility problems, and the company has established a preventive maintenance program. Regular service and minor repairs are performed at satellite terminals, with major overhauls performed at the central terminal. Drivers are trained to inspect and adjust brakes and to conduct pre-trip and post-trip vehicle inspections.

The company adopts new safety technology according to the following criteria: the product should be price competitive, proven on the road, and guaranteed by the manufacturer. New tractors are equipped with automatic slack adjusters and governors set at 62 mph. The company does not plan to equip its tractors with antilock brakes, which it feels do not meet its criteria.

sure and forces difficult choices between offering rate discounts to attract business and maintaining rates to generate revenue.

Changes in economic regulation affected market entry, operations, costs and pricing, employment policies and labor relations (including wage levels), and technology development. The distinctions between various types of regulated motor carriers greatly diminished after deregulation, and entry opportunities for private carriers and owner-operators improved.

The nature and volume of the business conducted by various segments of the trucking industry has changed, becoming less predictable. Large general commodity carriers tend to specialize in LTL shipments. While many large LTL carriers have failed, a few of the largest nationwide LTL carriers have expanded and prospered. Few newly formed carriers have entered the LTL business; existing LTL carriers have competed fiercely for each other's markets. Small carriers and owner-operators have captured a larger portion of the TL market, in part because of lowered entry barriers and more pricing freedom. New entrants tend to be small and nonunion, often coming from the ranks of owner-operators, a key part of this fleet. The interstate portion of the TL industry has become more diverse and more dispersed.

Profit margins have fallen, even for the most successful carriers, under pressure from intense price competition that is partly a result of changes in manufacturing and partly of continuing overcapacity. Expenses per ton-mile are up 75 percent since 1978, while general freight revenues per ton-mile have increased only 54 percent. Freight rates have also fallen behind price increases in the general economy, particularly for large shippers and those in highly competitive city-pair traffic lanes. Carriers that serve small shippers and those in less competitive markets have fared better.

Other factors have also changed the framework in which carriers compete.

- Unregulated commercial zones have been greatly expanded, opening larger areas to local carriers.

- Shippers now frequently utilize fewer carriers with comprehensive operating territories to take advantage of cumulative discounts and service commitments in return for guaranteed freight volumes.
- Truckload carriers establish defined traffic lanes with certain shippers (e.g., between two plants of the same shipper) and capture a steady, balanced volume of business under contract.

The traditional driver pool has been shrinking, and carriers have had to provide incentives to attract drivers. Rate discounting, however, has made low labor costs and high productivity essential to survival, so carriers find it difficult to increase driver wages and improve arduous work conditions.

Safety Implications

Trucks have become significantly bigger and heavier since deregulation, primarily in response to Federal legislation requiring States to allow longer, wider trailers and heavier gross weights. For similar reasons, double trailers are rapidly becoming commonplace on the Interstate System. These changes in truck equipment have not been matched by upgraded roadway design and capacity, and as automobile traffic has increased, urban peak-hour congestion has become severe in many jurisdictions. Such road and traffic conditions increase the likelihood of an accident.

Price discounting and low profit margins create difficult economic trade-offs for investments in safety-related equipment and maintenance. These trade-offs are particularly problematic for owner-operators and small carriers, who have to generate revenue regularly to stay in business and may have no regular maintenance facility.

Carriers are, in general, interested in safety, but will measure investments in new safety equipment and technologies against tangible economic rewards. Competition, increased costs, and low, erratic profit margins create a need to control costs that may lead to shortchanging truck maintenance and equipment improvements. **OTA concludes that Federal safety regulations will affect carriers economically with varying severity, depending on their financial reserves and stability.**

Requirements to operate trucks safely should not depend on commodity, corporate form, or destination of the cargo, the traditional basis of ICC regulation. Safety regulations have gradually been extended to trucks operating in intrastate, private, and exempt services, and these perform a large share of the Nation's highway transportation. **OTA concludes that the need for safety does not vary with the type of operation, and that no exemptions from safety regulations are warranted.**

Chapter 3

Federal and State Regulatory Programs

U.S.
FEDERAL
HIGHWAY
ADM.

Photo credit: California Department of Transportation

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Chapter 3

Federal and State Regulatory Programs

Highway safety, particularly for motor carriers, has long been a Federal and congressional concern. Multiple regulatory programs, administered by different agencies within the Department of Transportation (DOT) set minimum standards for vehicle equipment, driver qualifications, and commercial motor carrier operations, and for the highways on which the vehicles operate. The Federal Government also provides funds to State and local jurisdictions for construction and maintenance of highways, bridges, and tunnels, and for State highway safety programs. Although Federal economic control of the trucking industry has dwindled significantly since deregulation in 1980, some years ago Congress began a series of legislative steps toward a comprehensive Federal motor carrier safety program. Systematic efforts to improve highway safety are limited by interjurisdictional issues and conflicts at many governmental levels, however. Moreover, numerous Federal agencies and congressional committees share responsibility for creating and enforcing safety legislation, creating further complications. Because the efforts of these groups are difficult to coordinate, and no single group has ultimate responsibility, addressing truck safety in a systematic, integrated way has to date proven an unachievable task.

In addition, many States impose substantial economic and safety requirements on intrastate carriers. Yet, while Federal grants for State programs have greatly enhanced State inspection and enforcement capabilities, the scope of these programs varies significantly. Despite this extensive Federal and State regulatory and enforcement framework, heavy vehicle transportion has grown annually, and safety issues persist.

This chapter describes the Federal laws and regulatory programs governing motor carrier operations and the efforts of the Federal Government and the States to improve safety. Policy options are identified in the final section. A chronology of motor carrier legislation (appendix 3-A), and a brief history of motor carrier regulations (appendix 3-B) appear at the end of this chapter.

FEDERAL SAFETY LEGISLATION

Commercial motor vehicles are defined by law as those: 1) weighing 10,001 pounds or more, 2) designed to transport more than 15 passengers, including the driver, or 3) used to carry hazardous materials in quantities requiring vehicle placarding. (Lightweight vehicles are those weighing 10,000 pounds or less.) Although economic regulation by the Interstate Commerce Commission (ICC) of the motor carrier industry was substantially reduced in 1980, the regulatory changes did not encompass Federal safety regulations. Laws enacted since 1980 have strengthened and expanded coverage by Federal safety standards, and Congress has promoted greater national uniformity by establishing consistent size and weight laws, and by encouraging States to adopt Federal regulations.

The Surface Transportation Assistance Act of 1982

The primary goal of the Surface Transportation Assistance Act of 1982 (STAA) was to fund improvements to the Nation's highways, bridges, and mass transit facilities by raising and restructuring existing highway taxes.[1] As a concession to the commercial motor carrier industry, the statute also called for uniform weight, length, and width limitations on trucks and buses using major, federally funded highways. Overriding existing State laws, the STAA prohibited States from setting a maximum gross vehicle weight limit under 80,000 pounds for

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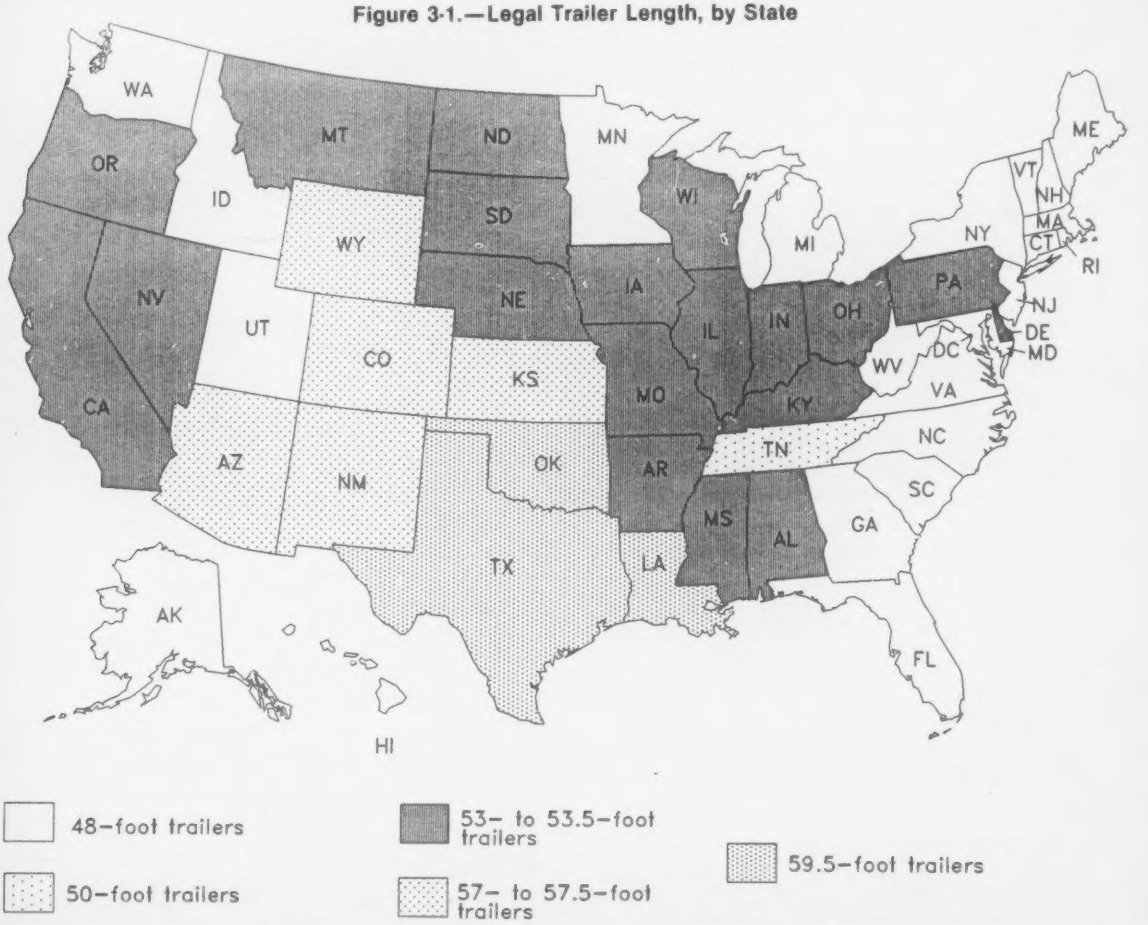
[1] Public Law 97-424, 96 Stat. 2097 (Jan. 6, 1983).

vehicles operating on any portion of the Interstate system. Additionally, the act prohibited States from denying trucks reasonable access between these highways and facilities for food, fuel, repairs, and rest; and to points of loading and unloading (for household goods carriers). In 1984, the STAA was amended to allow Governors to seek exemptions for Interstate highway segments in their States that could not safely accommodate longer trucks.[2]

In addition, States were prohibited from barring trucks with twin trailers from Interstate highways or certain Federal-Aid Primary routes designated by DOT.[3] States also were required to permit truck semitrailers of 48 feet in length for one trailing unit and 28 feet each for two trailing units on these roads. Maximum length limits were not set, however, and legal trailer lengths vary significantly among the States (see figure 3-1), with many States permitting trailers even longer than 48 feet. States were also required to establish and enforce a vehicle width limit of 102 inches for Interstate highways or any other Federal-aid highway designated by DOT, pro-

Figure 3-1.—Legal Trailer Length, by State


WA
OR
CA
ID
NV
MT
WY
UT
AZ
CO
NM
ND
SD
NE
KS
OK
TX
MN
IA
MO
AR
LA
WI
IL
MS
MI
IN
KY
TN
AL
OH
WV
GA
FL
PA
DC
VA
NC
SC
NY
VT
NH
MA
CT
RI
NJ
DE
MD
ME
AK
HI
48-foot trailers
50-foot trailers
53- to 53.5-foot trailers
57- to 57.5-foot trailers
59.5-foot trailers

NOTE: Semitrailers in Wisconsin, Indiana, and California must conform to a State specified king-pin-to-rearmost axle distance to operate without a permit.

SOURCE: Office of Technology Assessment, 1988, based on the 53 *Federal Register* 19 (Jan. 19, 1988).

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[2] Tandem Truck Safety Act of 1984, Public Law 98-554, 98 Stat. 2829. The act also modified the reasonable access provision of the Surface Transportation Assistance Act to include 28-feet by 102-inch single-trailer units; this amendment was made to codify existing industry practice, as 28-foot trailers are replacing the standard 48-foot trailers for pickup and delivery service.

[3] See 23 CFR 658, app. A.

vided that the traffic lanes were designed to be at least 12-feet wide. Procedures allowing a State Governor to notify DOT of highway segments not capable of accommodating 102-inch-wide vehicles and to request an exemption, identical to those relating to truck length, were established by Congress in 1984.[4]

The safety issues associated with longer, wider trucks are extremely controversial. Some segments of the trucking industry argue that longer trucks are needed to improve productivity. Other industry groups and many States and safety advocates believe that such vehicles pose a safety hazard even when operating over designated highways and access routes. Chapters 4 and 5 contain more detailed assessments of the performance and operation of longer combination vehicles on the existing highways. A discussion of State access requirements is presented later in this chapter.

The STAA also authorized funds for State inspection and enforcement programs through a Federal grant program—the Motor Carrier Safety Assistance Program (MCSAP)—to improve State capabilities to inspect heavy vehicles and enforce motor carrier safety regulations. Under this program, some DOT control over intrastate carriers was initiated—to qualify for MCSAP funds, States were required to adopt the Federal motor carrier safety regulations or compatible State requirements. MCSAP has become an important part of overall truck safety efforts in recent years, promoting uniform regulations, enforcement activities, and Federal-State coordination. The program is detailed later in this chapter.

Motor Carrier Safety Act of 1984

Concerned about inconsistent State laws and regulations and about the adequacy of existing Federal regulations, Congress passed the Motor Carrier Safety Act of 1984.[5] Specifically, the act directed DOT to promulgate revised Federal regulations establishing minimum standards to ensure that:

- commercial motor vehicles were safely maintained, equipped, loaded, and operated;
- the responsibilities imposed upon operators of commercial motor vehicles did not impair their ability to operate such vehicles safely;
- the physical condition of operators of commercial motor vehicles was adequate for them to operate such vehicles safely; and
- the operation of commercial motor vehicles did not have deleterious effects on the condition of such operators.

Before issuing revised regulations, DOT was required to consider costs and benefits as well as State laws and regulations to minimize Federal preemption. Furthermore, Congress requested a 5-year review of State motor carrier laws to identify those differing substantially from Federal requirements. Additional provisions of the 1984 act called for annual commercial motor vehicle inspections, the establishment of Federal inspection standards, a comprehensive study on the safety characteristics of heavy trucks, and an investigation and study of crash protection for truck occupants.

1986 Commercial Motor Vehicle Safety Act

The adequacy of requirements for drivers of commercial motor vehicles has been a primary concern of safety-conscious officials. A key element of the 1986 act is that truck drivers are prohibited from holding more than one State license, a provision that became effective on July 1, 1987.[6] The act also directed DOT to establish minimum written and road tests for drivers by July 15, 1988. Motor vehicles covered by the act are those weighing 26,001 pounds or more; however, the Secretary of Transportation is authorized to lower the threshold to 10,001 pounds. Motor vehicles used to carry hazardous materials or designed to transport more than 15 passengers, including the driver, are also included.

Under the provisions of the act, a driver must be road-tested in a vehicle representative of the type he or she will operate, and minimum passing scores for written tests must be established. Furthermore, drivers taking these tests must have a working knowledge of the Federal Motor Carrier Safety Regulations (FMCSR) and vehicle safety systems. DOT must also establish a blood-alcohol concentration

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[4] Tandem Truck Safety Act of 1984, op. cit., footnote 2.

[5] Public Law 98-554, 98 Stat. 2832 (Oct. 30, 1984).

[6] Drivers are also required to notify employers if they have been disqualified from operating a commercial motor vehicle, and employers and States must be notified of all traffic violations, except parking infractions. (49 CFR 383.)

(BAC) standard by October 1988, and is currently considering a BAC level of 0.04 percent.[7]

To support an effective single-license system, DOT must establish a Commercial Driver's License Information System by January 1, 1989.[8] Data in the system, including the information required on licenses and driver compliance records, will be available to DOT, States, employers, and employees.

States are not required to have fully operational programs until 1993. Grants will be made available to develop testing and licensing programs, to test operators of commercial motor vehicles, and to participate in the national information clearinghouse.[9] However, a State that fails to comply with the requirements of this act will lose 5 percent of its Federal-aid highway funds in 1994 and 10 percent of its funds in subsequent years.

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[7] To support this rulemaking effort, the Department of Transportation requested a study by the National Academy of Sciences to assess the differences between 0.10 and 0.04 blood-alcohol concentration levels. For further details, see ch. 6.

[8] The Department of Transportation has the option of operating this system in-house or using another system employed by one or more States.

[9] Between 1987 and 1991, $5 million of the Motor Carrier Safety Assistance Program funds has been earmarked for basic grants. Supplemental grants, using $3 million of the Motor Carrier Safety Assistance Program and the National Highway Traffic Safety Administration highway safety funds, will be made available to States eligible for basic grants. An additional $5 million, also from the Motor Carrier Safety Assistance Program will be used to support information clearinghouse programs.

MULTIPLE FEDERAL ROLES

As the trucking industry has expanded over the past 50 years, Congress has gradually allocated safety responsibility for motor carriers to a variety of agencies. Authority for safety-related issues such as highway design, equipment regulation, hazardous materials transportation, driver qualifications, and enforcement was divided among different Federal agencies, making a systematic approach to safety an elusive goal. Attempts to improve motor carrier safety after deregulation have been further hampered by historical carrier exemptions from regulations and the lack of reliable data on the number of operators and trucks doing business. Currently, three DOT agencies—the Federal Highway Administration (FHWA), the National Highway Traffic Safety Administration (NHTSA), and the Research and Special Programs Administration (RSPA)—share responsibility for ensuring motor carrier safety (see table 3-1).

Department of Transportation: Federal Highway Administration

Within FHWA, the Office of Motor Carriers (formerly the Bureau of Motor Carrier Safety) issues and enforces the FMCSR.[10] These regulations, summarized in table 3-2, govern the operations of commercial motor carriers and truck drivers. FHWA is responsible for setting minimum levels of financial responsibility for commercial motor carriers (49 CFR 387) and adminstering MCSAP. Data systems maintained by FHWA contain enforcement and accident statistics (see chapter 7).

In addition, interstate commercial motor carriers—public and private—must be assigned one of three safety fitness ratings by FHWA to acquire ICC approval. However, carriers may operate with temporary ICC approval while awaiting an FHWA fitness rating. At the end of a terminal inspection, known as a safety review, FHWA rates carriers satisfactory, unsatisfactory, or conditional. DOT has dropped the insufficient information rating it used to give when it lacked the information on which to base a rating.[11] The factors in determining safety ratings include any violations discovered during safety management audits and driver equipment compliance reviews in the previous 5 years, the operator's record of improvement over that period, the

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[10] Under a reorganization plan announced in October 1986, the Bureau of Motor Carrier Safety was replaced by the Office of Motor Carriers.

[11] Prior to 1983, an insufficient rating was automatically elevated to a satisfactory rating after 1 year from the date it was assigned, if the rating was not, in that time, changed to unsatisfactory or conditional. Until recently, carriers assigned an insufficient information rating retained such a rating until the Department of Transportation received definitive positive or negative information on which to change a rating. See 48 *Federal Register* 22565 (May 19, 1983).

Table 3-1.—Overview of Federal Regulatory Responsibilities for Motor Carrier Safety

Department of Transportation Administration	Senior Official	Responsibilities
Federal Highway Administration (FHWA)	Associate Administrator for Engineering and Program Development	Determines how truck access affects the highway system
	Associate Administrator for Research, Development and Technology	Manages research on the adequacy of highway design to accommodate trucks
	Associate Administrator for Motor Carriers	Establishes and enforces operating regulations for commercial motor carriers; includes driver and maintenance requirements
	Associate Administrator for Policy	Studies the implications of longer combination vehicle used on the Nation's highway system
National Highway Traffic Safety Administration (NHTSA)		Establishes regulations for the manufacture of new vehicles and related equipment; investigates safety-related equipment defects
Research and Special Programs Administration (RSPA)		Establishes and enforces regulations for containers used in transportation of hazardous materials

SOURCE: Office of Technology Assessment, 1988.

operator's accident record, and violations of State-related laws or regulations.[12]

FHWA plans to assign safety fitness ratings to the 185,000 unrated carriers within the next 3 to 5 years,[13] and recently, FHWA hired 150 new field safety investigators to conduct safety reviews and provide technical assistance to carriers. As of July 1988, ratings of 58,270 motor carriers (see table 3-3) had been completed. FHWA rated 8 percent of the carriers unsatisfactory, 40 percent conditional, and 52 percent satisfactory.

To reduce the risks associated with preventable accidents, FHWA plans to work with individual companies that have poor safety records and will meet with industry associations to discuss the use of countermeasures. This type of program was successful in FHWA's northwest region, and a small national effort has been started.

Each of the nine FHWA regional offices has an Office of Motor Carrier Safety. These regional offices investigate accidents and provide technical support and direction to safety investigators who conduct audits of motor carriers and vehicle inspections. Under MCSAP, however, States have assumed lead responsibility for roadside inspections, and most State MCSAP agencies have focused initially on developing and implementing vehicle and driver inspection programs. FHWA has greatly reduced its roadside inspection activities while increasing carrier terminal audits (see table 3-3).

FHWA has also been responsible for developing a highway access policy for large trucks, and issued a rulemaking in 1982 permitting the trucks author-

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[12] 49 CFR 385.3. These factors were formally codified in 1982 in response to industry criticisms pointing to the lack of objectivity in the factors, the lack of notice to carriers of their safety ratings, and the lack of an appeals procedure. See 47 *Federal Register* 26135 (June 17, 1982).

[13] Gerald J. Davis, chief, Federal Programs Division, Office of Motor Carriers, Federal Highway Administration, personal communication, Mar. 25, 1987.

Table 3-2.—Summary of DOT Motor Carrier Safety Regulations in Title 49 of the Code of Federal Regulations

Part 325: Compliance With Interstate Motor Carrier Noise Emission Standards.—Establishes procedures for inspection, surveillance, and measurement of motor vehicles to determine compliance with noise emission standards.

Part 350: Commercial Motor Carrier Safety Assistance Program.—Establishes guidelines for the development and implementation of State programs for the enforcement of Federal motor carrier safety regulations. Conditions, objectives, and funding of the program are also detailed.

Part 383: Commercial Driver's License Standards; Requirements and Penalties.—Requires that drivers have a single commercial motor vehicle driver's license, and that drivers provide employers with information about previous employment and previous violations and suspensions. Also prohibits an employer from allowing a person with a suspended license to operate a commercial motor vehicle and sets penalties for violations.

Part 385: Safety Ratings.—Prescribes procedures for issuing motor carriers ratings of satisfactory, unsatisfactory, or conditional. Also lists the factors to be considered in determining a safety rating and sets procedures for notification and review.

Part 386: Rules of Practice for Motor Carrier Safety and Hazardous Materials Proceedings.—Authorizes the Associate Administrator for Motor Carriers of the Federal Highway Administration (FHWA) to determine whether a motor carrier or person subject to the jurisdiction of FHWA has failed to comply with motor carrier safety regulations. Also authorizes the Associate Administrator to compel compliance, issue a civil penalty, or both.

Part 387: Minimum Levels of Financial Responsibility for Motor Carriers.—Establishes minimum level of financial responsibility required by motor carriers and mandates that motor carriers must have proof of insurance and authorization from the Interstate Commerce Commission in order to operate.

Part 388: Cooperative Agreements With States.—Authorizes any State to enforce FHWA safety regulations, and establishes terms of eligibility, cancellation, exchange of information, and requests for assistance.

Part 389: Rulemaking Procedures—Federal Motor Carrier Safety Regulations.—Establishes rulemaking procedures that apply to the issuance, amendment, and revocation of Federal Motor Carrier Safety Regulations.

Part 390: Federal Motor Carrier Regulations, General.—Establishes definitions and applicability of regulations. (For list of exemptions, see table 3-5.)

Part 391: Qualifications of Drivers.—Establishes minimum qualifications for motor carrier drivers (i.e., to qualify to drive a commercial motor vehicle, part 391 states that a person must be at least 21 years old, have a currently valid commercial motor vehicle operator's permit, have prepared and furnished the motor carrier that employs him with a list of violations, have successfully completed and been issued a certificate of driver's road test or an equivalent). In addition, part 391 establishes minimum duties of motor carriers with respect to the qualifications of their drivers.

Part 392: Driving of Motor Vehicles.—Establishes driving practices in cases of railway grade crossings, drawbridges, and hazardous driving conditions. Also sets regulations for use of lighted lamps and reflectors, accidents and license revocation, emergency signals, fueling precautions, and specifies prohibited practices.

Part 393: Parts and Accessories Necessary for Safe Operation.—Establishes requirements for motor carriers including lighting devices, reflectors and electrical equipment, brakes, glazing and window construction, fuel systems, coupling devices and towing methods, miscellaneous parts and accessories, emergency equipment, and protection against shifting or falling cargo.

Part 394: Notification and Reporting of Accidents.—Defines reportable accidents and establishes duties of motor carriers to make reports and keep records of accidents that occur during their operations.

Part 395: Hours of Service of Drivers.—Establishes hours-of-service regulations for drivers, restricting driving periods of more than 10 hours after 8 consecutive hours off duty, for any period after having been on duty for 15 hours after 8 consecutive hours off duty, or more than 60 hours in any consecutive 7 days. Regulations are also set for recording driver duty status.

Part 396: Inspection, Repair, and Maintenance.—Establishes requirements for the inspections, repair, and maintenance of commercial motor vehicles.

Part 397: Transportation of Hazardous Materials; Driving and Parking Rules.—Establishes requirements of transportation of hazardous materials including special parking, route, tire, and smoking regulations.

Part 398: Transportation of Migrant Workers.—Estabishes regulations governing the transportation of migrant workers for more than 75 miles when crossing the boundry of another State, a U.S. territory, or another country.

Part 399: Employee Safety and Health Standards.—Establishes step, handhold, and deck requirements that apply to drivers of trucks and truck-tractors, having a high profile cab-over-engine configuration for entrance, egress, and back of cab access, manufactured on or after September 1, 1982.

SOURCE: Office of Technology Assessment, based on Title 49 of the Code of Federal Regulations.

Table 3-3.—Federal Highway Administration Inspections and Audits, Fiscal Years 1980-87

	1980	1981	1982	1983	1984	1985	1986	1987
Number of Federal safety specialists	188	162	177	180	178	166	155	241
Number of driver/vehicle inspections	31,875	40,872	35,825	26,015	22,590	16,046	10,027	910
Number of motor carrier audits/reviews	7,093	9,640	12,095	11,666	13,037	10,492	6,637	23,714[a]

[a] This substantial increase reflects a transition at the Federal Highway Administration from safety audits to less in-depth safety reviews.

SOURCE: Office of Technology Assessment, based on Federal Highway Administration information, 1988.

ized by the STAA unlimited access on the Interstate system. (For further information, see the section on "Highway Access" later in this chapter.) The Association of State Highway and Transportation Officials has also influenced decisions related to highway access because it sets the standards for the construction and reconstruction of national highways. These standards have been determined primarily by the size and maneuverability of passenger cars, and in the case of many parts of the Interstate system, by a tractor pulling a 40- or 45-foot trailer. Because the standards were set and highways constructed before the size and operating characteristics of the longer trailers authorized by the STAA were known, standards are currently being revised (for further information, see chapter 5).

Department of Transportation: National Highway Traffic Safety Administration

NHTSA develops and enforces safety standards for newly manufactured vehicles and equipment, addressing such items as brakes, lights, tires, and seat belts. To support standard development, the agency collects accident data and sponsors research. However, these activities have not led to major new truck safety equipment standards in recent years. (For further details, see chapter 5.) NHTSA enforcement programs focus on vehicle and equipment testing and inspections to ensure compliance with existing standards. The agency also conducts investigations of safety-related defects[14] and issues criteria for inspections of motor vehicles that are used by State highway programs.[15]

Equipment Regulations

Responsibility for developing highway safety standards for use by State agencies is shared by NHTSA and FHWA:

- NHTSA administers the State standards for motor vehicle inspections, registration, driver education, traffic laws, traffic records, police traffic service, debris cleanup, and accident investigations and reporting.
- FHWA set standards for highway design, construction, and maintenance, traffic engineering, and identification and surveillance of accident locations through a number of agency divisions. These groups do not regularly coordinate with NHTSA or the Office of Motor Carriers. FHWA also has primary responsibility for the highway transportation of hazardous materials and enforcement activities for the highway mode.

Although FHWA and NHTSA regulations cover comparable areas, the rulemaking efforts of these agencies are distinct from each other. Moreover, historically poor interagency coordination within DOT has led to inconsistent regulations for newly manufactured vehicles and for operating standards for commercial motor carriers. Congressional action was required to resolve conflicting NHTSA and FHWA regulations for front brakes, for example; several inconsistencies in other brake requirements persist.

Recently, FHWA published a proposed rule that would require vehicle inspections at least once a year, as mandated by the Motor Carrier Safety Act of 1984.[16] Under the new rules, commercial vehicle operators are responsible for having all vehicles inspected, according to explicit standards, by individuals meeting specified FHWA qualifications. Inspectors would be required to complete vehicle inspection reports and operators to retain such reports for 1 year. Special markings on trucks and trailers would indicate the month and year of the last inspection. Operators registered in a State with an inspection program that meets the objectives of the FHWA program would be permitted to comply with State requirements in lieu of Federal regulations.

Department of Transportation: Research and Special Programs Administration

Regulations governing the transportation of more than 30,000 hazardous materials are issued by the Office of Hazardous Materials Transportation within

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[14] Regulations for enforcement of the National Highway Traffic Safety Administration standards and defects investigations are contained in 49 CFR 554.

[15] Subpart B of 49 CFR 570 specifies the criteria for vehicles with gross vehicle weight ratings of more than 10,000 pounds.

[16] 52 *Federal Register* 5913 (Feb. 26, 1987). In an earlier notice, the Federal Highway Administration requested comments on this issue. See 50 *Federal Register* 1245 (Jan. 10, 1985).

RSPA in DOT. RSPA regulations prescribe requirements for packaging to ensure effective containment during transport, and communication of the hazards posed by these materials through special shipping papers, markings, labels, and vehicle placards.[17]

RSPA's authority encompasses requirements for the design and performance of packages used to ship low-level radioactive materials and highway routing of all radioactive materials. The Nuclear Regulatory Commission is responsible for containers used to transport high-level radioactive materials.[18]

Interstate Commerce Commission

ICC regulates the motor carrier industry by granting operating authority to common and contract carriers, collecting economic operating data from the larger motor carrier companies, and monitoring rates. Although deregulation substantially eased the entry requirements for interstate for-hire motor carriers, operating authority must still be obtained from ICC by common and contract carriers and private carriers seeking for-hire authority.[19] Carriers exempt from ICC regulation include those engaged in private carriage, including intercorporate hauling, and in the transportation of specified agricultural commodities.[20]

Furthermore, purely intrastate motor carriage and transportation within ICC-designated commercial zones are not subject to ICC regulation.[21] A commercial zone is composed of a base municipality, all its contiguous municipalities, and all other municipalities and unincorporated areas within U.S. boundaries that are within specified distances of the base jurisdiction.[22] In April 1987, ICC issued a proposal to increase the size of commercial zones substantially and extend economic exemptions.

National Transportation Safety Board

The National Transportation Safety Board (NTSB), an independent agency reporting directly to Congress, has issued a number of special studies related to the qualifications of commercial motor vehicle drivers as well as numerous accident investigation reports containing extensive recommendations for amendments to FHWA regulations and industry practices. NTSB is currently focusing on the effects of drugs and alcohol on driver performance and commercial vehicle safety.

Motor Carriers Exempt From Federal Safety Regulations

While the FMCSR apply to common, contract, and private motor carriers of property, they do not cover several other categories of carriers (see table 3-4). Private motor carriers of passengers, such as school buses, are exempt from Federal regulations, while for-hire motor carriers of passengers, like Trailways and charter bus services, are not. Because Federal safety statutes have historically applied only to interstate transportation, many operations conducted solely within the boundaries of a State need not comply with the FMCSR.

In addition, vehicles and drivers used wholly within a municipality or a DOT-designated commercial zone, even if State lines are crossed, were for years exempt from Federal safety regulations unless they were transporting large quantities of hazardous materials.[23] In response to pressure from safety advocates, including Congress and industry organizations, FHWA finally issued a rulemaking that requires vehicles and drivers used in such local operations to comply with Federal safety regulations by November 15, 1988.

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[17] Hazardous materials regulated by the Research and Special Programs Administration are listed in 49 CFR 171. Regulations for containers are specified in 49 CFR 173, 178, and 179. Specific modal requirements are contained in Parts 174 (rail), 175 (air), 176 (nonbulk water transport), and 177 (highway). Regulations for bulk water shipments, developed by the U.S. Coast Guard, are specified in 46 CFR. Hazard communication requirements are in 49 CFR 172.

[18] Nuclear Regulatory Commission authority is derived from the Atomic Energy Act of 1954, 42 U.S.C. 2011. Issues related to the transportation of radioactive materials and hazardous substances were addressed in a 1986 OTA assessment, the *Transportation of Hazardous Materials*.

[19] Interstate Commerce Commission jurisdiction over motor carriers is specified in 49 U.S.C. 10521.

[20] Carriers exempt from the Interstate Commerce Commission's regulations are specified in 49 U.S.C. 10522-10524 and 10526. However, companies that intend to conduct intercorporate hauling must notify the Interstate Commerce Commission as required by 49 CFR 1167.

[21] 49 U.S.C. 10525 and 10526(b). Intrastate transportation that is regulated by the Interstate Commerce Commission includes two situations where: 1) the normal route of a carrier between two points in the same State includes a highway outside the State, or 2) transportation between two points in the same State that precede or follow interstate movement are considered interstate in nature because they pass the "essential character of commerce" test. Daniel Sweeney et al., *Transportation Deregulation: What's Deregulated and What Isn't* (Washington, DC: NASSTRAC, 1986), pp. 109-110.

[22] For example, the distance for municipalities with populations under 2,500 is 3 miles, while the distance for municipalities with populations over 1 million is 20 miles. See 49 CFR 1048.101.

[23] 49 CFR 390.16. This exemption did not apply to operations in Hawaii.

Table 3-4.—Regulatory Exemptions to Title 49 of the Code of Federal Regulations

Vehicle/driver type	Parts (for summary of parts, see table 3-2)						
	391[a]	392	393	394	395	396	397
Vehicles owned, operated, and regulated by Federal, State, or local goverments	X	X	X	X	X	X	X
Private carrier of passengers (i.e., school buses)	X	X	X	X	X	X	X
Intracity operations[b]	X	X	X	.....	.....	X	X
Lightweight mail trucks[c]	X	X	X	X	X	X	.....
Farm custom operations[d]	X	.....	.....	.....	.....	.....	.....
Certain farm vehicle drivers[e]	X	.....	.....	.....	.....	.....	.....
Farm-to-market operations[f]	.....	.....	.....	X	.....	.....	.....
Apiarian industries[g]	X	.....	.....	.....	.....	.....	.....
Drivers traveling beyond a commercial zone, transporting cargo other than explosives or other dangerous articles	.....	.....	.....	.....	.....	.....	X

KEY: X = exemption from requirement.

[a] Drivers in the following categories are exempt from portions of Part 391: drivers regularly employed before Jan. 1, 1971; intermittent or occasional drivers; drivers furnished by other motor carriers; drivers of articulated farm vehicles; intrastate drivers of vehicles transporting combustible liquid; and drivers operating in the State of Hawaii. The Department of Transportation has ended this exemption effective Nov. 15, 1988.

[b] This exemption applies to vehicles or drivers wholly within a municipality or commercial zone, unless transporting hazardous materials that require a placard and weigh 2,500 pounds or more in the case of one dangerous article, or 5,000 pounds or more in the case of more than one dangerous article. The exemption does not apply to drivers in the State of Hawaii. The Department of Transportation has ended this exemption effective Nov. 15, 1988.

[c] This exemption applies to motor carriers used exclusively to tranport mail under contract with the U.S. Postal Service that have a gross vehicle weight of 10,000 pounds or less.

[d] This exemption applies to drivers who operate motor vehicles controlled and operated by a person engaged in custom-harvesting, if the vehicle is used to transport farm machinery or supplies to or from a farm for custom-harvesting operations, or used to transport custom-harvested crops to storage or market.

[e] This exemption applies to farm vehicle drivers, except those driving articulated motor vehicles with gross vehicle weights, including loads, of more than 10,000 pounds.

[f] This exemption applies to drivers of vehicles controlled and operated by a farmer who, as a private carrier, is using the vehicle to transport agricultural products from his farm, or to transport farm machinery, farm supplies, or both to his farm. Drivers transporting hazardous materials that require a placard are not exempt.

[g] This exemption applies to drivers operating motor vehicles controlled and operated by a beekeeper engaged in the seasonal transportation of bees.

SOURCE: Office of Technology Assessment, based on 49 CFR 390.33.

STATE PROGRAMS

State economic and safety regulatory programs governing the operations of motor carriers are extensive. States require motor carriers to register their vehicles, obtain operating authority and insurance, pay a variety of taxes, adhere to truck weight and size limitations, and comply with safety regulations, including special routing or scheduling restrictions. In most States, multiple agencies are responsible for administering these programs. For instance, departments of finance or revenue assess taxes, departments of motor vehicles or transportation register vehicles, and a public utilities commission or commerce department may grant operating authority. Safety regulations, including those for the transportation of hazardous materials, may be issued and enforced by departments of transportation, public safety, health, or environment, or by the State police (see table 3-5 for a sample of State agency authority).

Improving State Capabilities

Beginning in the late-1960s, FHWA entered into cooperative agreements with States to bolster roadside inspection activities. However, no Federal financial support was provided, limiting the effectiveness of most State programs. Ten years later, FHWA funded demonstration programs in Alaska, Idaho, Michigan, and Utah to improve safety inspections and to monitor truck size and weight. These States were encouraged to adopt the FMCSR, and State inspectors were trained to enforce them. The data collected underscored the importance of effective State enforcement as an accident prevention tool. For example, in the year Utah increased its inspections by 330 percent, a 43-percent reduction in accidents involving commercial motor vehicles occurred. Similarly, Idaho experienced 37 percent fewer commercial accidents in the year that it increased its inspections by 268 percent and its weighings by 218 percent.[24]

Many State motor carrier safety programs have altered significantly since 1980. At that time, reduc-

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[24] U.S. Department of Transportation, Federal Highway Adminstration, Bureau of Motor Carrier Safety, "Interim Report, Commercial Motor Carrier Safety Inspection and Weighing Demonstration Program," unpublished manuscript, August 1981.

Table 3-5.—Agencies Administering Motor Carrier Requirements in Selected States

State motor carrier requirements	Arizona	New York	Virginia	Iowa	Minnesota
Registration and taxes					
Vehicle registration	MVD	DMV	DMV	MVD	DPS
Fuel use tax	MVD	TAX	DMV	MVD	DOR
Fuel sales tax	—	TAX	DMV	—	—
Out-of-State fuel tax	—	TAX	—	MVD	—
Fuel surtax	—	—	SCC[a]	—	—
Gross receipts tax	—	TAX[b]	—	—	—
Weight/distance tax	MVD	TAX	—	—	—
Economic regulation					
Initial ICC regulation	—	DOT	SCC	MVD	DOT
Supplemental ICC registration	—	—	—	MVD	DOT
Identification stamp	—	DOT	SCC	MVD	DOT
Other regulations					
Certificate of insurance	MVD	DMV	SCC	MVD	DOT
Safety issues	MVD	DMV	SP	MVD	DOT
Hazardous materials	DHS	DEC	DOH	TRA	DOT
Size and weight	MVD	DMV	DH&T	MVD	DOT

KEY: DEC = Department of Environmental Control
DH&T = Department of Highways and Transportation
DHS = Department of Health Services
DMV = Department of Motor Vehicles
DOH = Department of Health
DOR = Department of Revenue
DOT = Department of Transportation
DPS = Department of Public Safety
ICC = Interstate Commerce Commission
MVD = Motor Vehicle Division
SCC = State Corporation Commission
SP = State Police
TAX = Department of Taxation and Finance
TRA = Transportation Regulatory Authority

[a] Virginia considers this a second structure tax.
[b] New York also imposes a Franchise Tax.

SOURCE: Office of Technology Assessment, adapted from National Governors' Association Working Group on State Motor Carriers Issues, "Current Efforts to Improve the Administration of State Motor Carrier Requirements, Report No. 7," November 1985, pp. 11-17.

tions in Federal inspection activities, major changes in the motor carrier industry, and concerns about truck-related accidents, all pointed to the need for stronger State enforcement. With Federal support, State inspection and enforcement programs expanded, and a higher percentage of trucks and drivers are placed out of service for violations.

However, until the STAA was passed in 1982, requiring States accepting Federal funding for enforcement to adopt Federal regulations, no formal means of coordinating Federal and State regulations existed. With the participation of State-based organizations, such as the National Governors' Association, some progress has been made in coordinating State economic and safety regulatory policies and activities. Nonetheless, varied and changing State regulations still affect interstate carriers.

The Motor Carrier Safety Assistance Program

Based on the success of these demonstration programs, State commercial motor vehicle safety programs have been federally supported by MCSAP since 1984.[25] The primary goal of MCSAP is to increase and improve State capabilities to enforce uniform motor carrier safety and hazardous materials regulations for both interstate and intrastate motor carriers and drivers through safety inspections of commercial motor vehicles in terminals and along roadsides. Data collection and analysis is a secondary goal, and States may use grant funds to develop an accurate database on regulatory compliance. Currently, all States except Alaska, New Mexico, South Dakota, Vermont, and Wyoming participate in MCSAP.[26] Because recent legislation intended to phase in the FMCSR in Texas was challenged by industry, Texas is not qualified to receive funds from MCSAP, at least for the present.

Two types of State grants—development and implementation—are available under MCSAP.[27] Development grants, available for a maximum of

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[25] The Motor Carrier Safety Assistance Program was authorized under the Surface Transportation Assistance Act of 1982, Public Law 97-424.

[26] In addition, participating U.S. territories include American Samoa, Guam, Puerto Rico, and the Virgin Islands.

[27] Requirements for State participation in the Motor Carrier Safety Assistance Program are contained in 49 CFR 350.

3 years, may be used by States to establish or substantially modify an enforcement program. Development activities include program planning, initiating legislative or regulatory action, formulating a budget, designating the State agency responsible for administering MCSAP, and preparing a State Enforcement Plan (SEP). FHWA guidelines require that an SEP cover the following:

- current status of commercial motor carrier operations, including traffic volume, seasonal patterns, and accident statistics;
- current enforcement efforts, including the role of State agencies, the personnel involved, the facilities and equipment utilized, and the number of inspections and audits conducted;
- evaluation of the current motor carrier safety program and the identification of problem areas;
- objectives and goals of the State program, such as hiring and training additional staff, increasing the number of inspections and audits, and revising legislation;
- description of how resources will be used to accomplish objectives; and
- method for evaluating program effectiveness.[28]

Development grants were awarded to 21 States and territories during fiscal year 1985. By 1987, however, most States had progressed to the implementation phase of MCSAP.

Implementation grants provide funding for States ready to initiate enforcement programs or enhance established ones. Activities may include recruiting and training of personnel, acquiring and maintaining equipment, conducting new or expanded inspections, and establishing an "out-of-service" and compliance enforcement system. To qualify for an implementation grant, a State must:

- agree to adopt and enforce the FMCSR (49 CFR 390-399), including highway-related portions of the Federal Hazardous Materials Regulations (49 CFR 171-173 and 177-178) or compatible State rules, regulations, standards, and orders applicable to motor carrier safety;
- submit an SEP and designate a lead agency for administering the plan;
- agree to devote adequate resources to administration of the program and enforcement of rules, regulations, standards, and orders;
- have established statutory authority to enforce Federal or compatible State regulations, regulate private and for-hire carriers, and provide for right-of-entry into vehicles and facilities;
- agree to adopt uniform reporting requirements and submit reports as requested by FHWA; and
- require registrants of commercial motor vehicles to declare knowledge of applicable Federal or compatible State regulations.

MCSAP is financed by the Highway Trust Fund and State appropriations. Federal grants of 80 percent must be matched by 20 percent from States.[29] Initially, incremental funding for MCSAP was authorized over a 5-year period: $10 million was authorized for fiscal year 1984, and $10 million was to be added each year, up to a maximum of $50 million by fiscal year 1988. However, grants awarded in 1985 and 1986 were significantly lower than authorized funding levels—less than $15 million in 1985 and approximately $17 million in 1986. For fiscal year 1987, the Secretary of Transportation requested that the $50 million maximum funding level for MCSAP be authorized to meet the needs of expanding State programs; State grant requests for 1987 exceeded $44 million. Due to budget cuts for fiscal year 1988, State grant requests were just under $42 million.

While a primary objective of MCSAP is to encourage States to adopt uniform regulations and implement consistent inspection and enforcement policies and procedures, significant differences among State programs persist. Among the factors affecting the scope and effectiveness of State programs are:

- the degree to which State legislation allows compliance with MCSAP, including the authority to regulate for-hire and private carriers;
- the adoption of Federal regulations or compatible State rules;

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[28] 49 CFR 350.13, app. A, and U.S. Department of Transportation, Federal Highway Adminstration, "Suggested Standard Implementation Grant Application," unpublished manuscript, April 1986.

[29] Funds available to any State for proposed program development may not exceed $50,000 per year. Implementation grant funds are distributed to the States according to an allocation formula based on the following factors in equal proportion: road mileage (all highways), vehicle-miles traveled (all vehicles), number of commercial vehicles over 10,000 pounds, population, and special fuel consumption (net reciprocity adjustment). See 49 CFR 350.21.

- the extent to which accident and inspection data are collected, analyzed, and used to support regulatory and enforcement policies;
- the extent to which States conduct safety audits at carrier facilities, in addition to roadside inspections;
- the number of inspectors employed, the ability of State agencies to compensate employees for overtime, and the availability and quality of inspector training programs; and
- the ability of enforcement officers to issue citations for violations and the issuance of penalties sufficiently high to be a deterrent to noncompliance.[30]

Regulatory Consistency

States participating in MCSAP often must pass enabling legislation authorizing the adoption and enforcement of Federal motor carrier safety and hazardous materials regulations or compatible State regulations. In addition, State regulations must apply to both private and for-hire carriers, and State enforcement personnel must have authority to conduct inspections of both intrastate and interstate motor carriers. Yet, despite these Federal requirements, laws in a number of States continue to limit the scope and applicability of motor carrier safety programs. FHWA has under way a review to determine the status of motor carrier safety legislation in each State—a task that FHWA officials estimate will take more than a year.

In addition, some States restrict the activities of law enforcement personnel. Kentucky prohibits audits of motor carrier operations, and Mississippi inspectors received authorization to inspect carriers other than for-hire carriers of property or persons as recently as July 1, 1988. Enforcement officials in Maryland are limited by State legislation prohibiting adoption of hours-of-service regulations for intrastate drivers working within a 100-mile radius.[31] State hazardous materials transportation laws also vary, with some States exempting specific commodities, while others apply hazardous materials regulations only to quantities that require placards under Federal law.[32]

To address the issue of regulatory consistency, Congress requested a 5-year review of State commercial motor carrier safety laws and regulations.[33] A panel convened by the Secretary of Transportation is determining whether State laws and regulations are more or less stringent than Federal requirements. State laws and regulations that are found to be less stringent than their Federal counterparts will be preempted and may not remain in effect after October 30, 1989. A State law or regulation that is more stringent will not be preempted unless there is no safety benefit associated with it, the law is not compatible with Federal regulations, or enforcement of it causes an undue burden on interstate commerce.

Highway Access

Highway access policies differ markedly from State to State. FHWA was instructed to develop rules and guidelines for a National Truck Network for the larger trucks authorized under the STAA.

FHWA's rulemaking authorized trucks that met the uniform size and weight limits to travel on all Interstate highways and designated State primary highways and to have reasonable access off these highways to terminals and to facilities for food, fuel, repairs, and rest.[34] Because States resisted Federal limitations on their authority to restrict movements of these trucks, States were allowed to interpret the terms "reasonable access" and "terminal."[35] This permitted significantly varying State interpretations (see table 3-6), leading inevitably to industry appeals for uniform Federal standards. Carriers protest limits on access to shippers and terminals, and drivers claim that inadequate signage and complex route listings hamper their ability to travel legally.

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[30] For further information, see U.S. Congress, Senate Committee on Commerce, Science, and Transportation, *Motor Carrier Safety Assistance Program (MCSAP): Options Intended To Improve a Generally Successful and Cooperative Federal/State Partnership Promoting Truck and Bus Safety* (Washington, DC: U.S. Government Printing Office, June 1988).

[31] Ron Lipps, Maryland State Department of Transportation, Safety Division, personal communication, Oct. 8, 1987.

[32] Placards are symbols placed on the ends and sides of motor vehicles indicating the hazards of the cargo. Shipments of some hazardous materials, such as etiologic agents and consumer commodities, do not require placards. In addition, shipments of less than 1,000 pounds of certain types of hazardous materials do not have to be placarded. See 49 CFR 172.504.

[33] The Motor Carrier Safety Act of 1984, Public Law 98-554 (Oct. 30, 1984), 49 U.S.C. 2501 et seq.

[34] 23 CFR 658.

[35] Porter K. Wheeler, "State Regulatory Programs for Motor Carriers," OTA contractor report, May 1987.

Table 3-6.—Reasonable Access Provisions

	Access policy						
State	½ mile	1 mile	3 miles	5 miles	10 miles	Unlimited	Comments
Alabama		X					From identified designated interchanges.
Alaska						X	
Arizona						X	Width restrictions.
Arkansas						X	Unless otherwise posted.
California	X						Terminal access beyond ½ mile by signed routes from identified access points.
Colorado						X	Unless otherwise posted.
Connecticut		X					Special driver license needed for twins.
Delaware							By permit only.
District of Columbia							By permit only.
Florida							From identified interchanges: rural—1 mile (2 lane) and 3 mile (4 lane); urban—1 mile on crossroads with 12-foot lanes; carriers must petition terminals outside above limits.
Georgia		X					From identified interchanges: 60-foot limit.
Hawaii						X	Length restrictions.
Idaho						X	
Illinois				X			State highways and local roads to facilities.
Indiana						X	
Iowa							All U.S. and State routes. 5 miles from National Truck Network; all streets served by designated routes and 3-10 miles outside cities, depending on population.
Kansas						X	All U.S. and State routes.
Kentucky				X			
Louisiana			X				
Maine							2 miles in rural areas; ½ mile in urban areas.
Maryland							Shortest possible route to terminals.
Massachusetts							By permit only.
Michigan				X			
Minnesota							To facilities or for route continuance.
Mississippi						X	
Missouri					X		
Montana						X	
Nebraska						X	All U.S. and State routes.
Nevada						X	
New Hampshire							By permit only for twins.
New Jersey							By permit only for twins.
New Mexico							20 miles from Interstates, designated roads
New York							Permit required beyond 1,500 feet.
North Carolina			X				
North Dakota					X		
Ohio						X	All U.S. and State routes.
Oklahoma							Reasonable access (up to the discretion of enforcement officers).

(table continued on next page)

Table 3-6.—Reasonable Access Provisions—continued

State	Access policy						Comments
	½ mile	1 mile	3 miles	5 miles	10 miles	Unlimited	
Oregon							Unlimited on all but local roads—width only; twins, tractor-semitrailers not restricted.
Pennsylvania							0.2 miles.
Rhode Island							Doubles restricted to 1 urban mile; 1 mile on 2-lane roads and 3 miles on 4-lane roads in rural areas; others by permit only.
South Carolina						X	Twins to terminals allowed.
South Dakota						X	Access limited to loading docks, terminals, and maintenance facilities.
Tennessee						X	Shortest reasonable route.
Texas						X	Unless otherwise posted.
Utah						X	
Vermont							½ mile on designated interchanges; furthur distance by permit only.
Virginia	X						Permit required beyond ½ mile.
Washington						X	
West Virginia							Within 2 miles of designated route.
Wisconsin				X			
Wyoming						X	

SOURCE: Office of Technology Assessment, based on *Commercial Carrier Journal*, April 1988, pp. 80-81.

Several States, especially in the East, have relatively restrictive access provisions. In Pennsylvania for example, access to roads off the designated network is limited to 0.2 miles, except on specific routes listed in an 84-page manual.[36] Massachusetts has designated only a portion of its State highways as part of the National Truck Network, and has adopted a $50 permit requirement for carriers who want access to most other roads.[37] Connecticut requires all drivers of twin trailers to be tested and licensed in-State.[38] Many carriers support legislation to amend the STAA, establishing a uniform definition of "terminal" and "reasonable access" and permitting STAA trucks to travel on most roads and highways, unless a State convincingly demonstrates that a road cannot safely accommodate large trucks.

The Tandem Truck Safety Act of 1984 authorized universal access by double 28-foot trailers, aiding companies that operate doubles by granting unlimited access for pick up or delivery purposes once the twin trailers were uncoupled. Large carriers have taken advantage of this access provision, building terminals close to Interstate highways where each 28-foot trailer can be attached to a separate tractor, or the contents of the trailers transferred to smaller vehicles. Many small companies, however, claim they do not have the funds or type of operation necessary to develop this kind of network.[39]

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[36] J. Terry Turner, "Statement of the Interstate Carriers Conference on the Matter of Reasonable Access to the Designated Highway System," testimony before the Senate Committee on Commerce, Science, and Transportation, Subcommittee on Surface Transportation, Apr. 21, 1988, app. A.

[37] Duane W. Acklie, president, Crete Carrier Corp., testimony before the Senate Committee on Commerce, Science, and Transportation, Subcommittee on Surface Transportation, Apr. 21, 1988, p. 4.

[38] Thomas R. Stedman, vice president, National Private Trucking Association, testimony before the Senate Committee on Commerce, Science, and Transportation, Subcommittee on Surface Transportation, Apr. 21, 1988, p. 9.

[39] Richard D. Henderson, executive vice president, Private Truck Council of America, Inc., letter to Senator Exon, U.S. Congress, May 12, 1988.

Data Collection and Analysis

Establishing databases that track motor carrier compliance with safety regulations is an important component of many State programs. Data are used to target carriers for inspections and audits and to support legislative or regulatory actions.

Although MCSAP funds may be used to develop information systems, the extent to which various States collect and analyze data varies, and many States cite inadequate data as a major implementation problem for MCSAP. Enforcement efforts are hampered by incomplete records of carrier, vehicle, and driver violations. In addition, poor accident data prevent State authorities from identifying carriers with high preventable accident rates and from conducting regulatory compliance education programs.

The ability of a State to obtain a complete compliance profile of an interstate motor carrier or driver, by accessing Federal and State databases, is a key element of a current demonstration program. SAFETYNET, a Federal-State automated network, will eventually link FHWA's motor carrier safety database, containing information on more than 200,000 interstate carriers and 25,000 hazardous materials shippers, with State data systems. FHWA's database, described in more detail in chapter 7, includes information on driver and vehicle violations, basic demographic and profile data on interstate carriers and shippers, data from accident reports filed by carriers, and Federal enforcement actions.[40] Approximately 35 States currently retrieve information from the central database in Washington, DC. Of these, 22 States also transmit data to the central computer.[41]

Four States—Colorado, Michigan, North Carolina, and Oregon—were selected to participate in a SAFETYNET demonstration program. During the initial phase, users of SAFETYNET will be able to: input driver and vehicle inspection data; update and query inspection data and carrier census data; query safety management audit summary data, accident report summary data, and inspection workload data; and generate system reports.[42] Eventually, all States are expected to participate in SAFETYNET; however, full implementation may take as long as 10 years.

Inspection and Audit Programs

States conduct two basic types of inspections—roadside checks of vehicles and drivers and safety management audits. During a roadside check, an inspector examines a vehicle for mechanical problems and inspects documents, such as a driver's hours-of-service record and license, as well as shipping papers or route plans, if applicable. An audit, which is conducted at a carrier's terminal or other business office, involves a review of records on vehicle use and maintenance, driver files and logbooks, and accident and violation reports and records. Management policies and procedures may also be assessed, and any vehicles in the terminal at the time of an audit may be inspected as well.

In most States, the development of safety audit programs has lagged behind establishment of roadside inspection programs. Obtaining authority to conduct audits from State legislatures and providing adequate training for State inspectors have proven to be major obstacles. Because uniform standards and procedures for audits have not been established, State audit programs differ in the criteria used for targeting carriers, the analysis of data obtained from a carrier's files, and the extent to

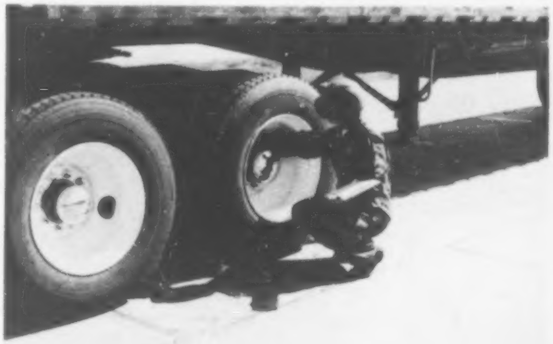

Photo credit: Commercial Vehicle Safety Alliance

Roadside inspections are a critical part of the MCSAP program.

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[40] See J.A. Reyes Associates, Inc., "SAFETYNET: The Motor Carrier Safety Information Network," prepared for U.S. Department of Transportation, Federal Highway Administration, November 1984.

[41] Angeli A. Sebastian, Federal Highway Administration, personal communication, Aug. 4, 1988.

[42] J.A. Reyes Associates, Inc., op. cit., footnote 40.

which compliance education and monitoring efforts are undertaken. Examples of well-developed State audit programs are provided in box 3-A. In addition, at least 17 States are assisting FHWA in rating carriers by conducting less in-depth safety and compliance reviews.[43]

Many States initially concentrate on roadside inspections, and States that have added enforcement personnel and increased inspections are placing higher percentages of vehicles and drivers out of service (see figure 3-2). For example, in Maine, when five new roadside inspectors were hired with MCSAP funds, 60 to 70 percent of the commercial motor vehicles inspected were placed out of service.[44] Similarly, in 1986, inspection teams in New York State failed 58 percent of approximately 3,200 trucks checked during roadside inspections on the Long Island Expressway and on highways near Albany and Buffalo.[45] In Connecticut, 13 Federal inspectors were hired in 1986 to assist 11 State officials in conducting roadside inspections. Subsequently, 5,000 motor carriers were placed out of service in fiscal year 1987, an increase of 1,500 over the previous fiscal year.[46]

Strategies for selecting vehicles to inspect vary among the States. Some conduct random roadside inspections, while others, such as Maryland, have begun to target trucks that appear to be in poor condition. Under Maryland's system, the percentage of vehicles placed out of service rose from 32 percent in 1985 to 63 percent in 1986, and the driver out-of-service rate increased from 3.7 to 8.3 percent during the same period.[47] In July 1986, Idaho implemented its inspection saturation program, which concentrates on one area of the State for 3 to 4 days. Officers are dispatched throughout surrounding areas, hindering driver attempts to avoid vehicle inspections.[48]

Many State inspection programs have strengthened emphasis on the driver, since enforcement officials believe that increased driver surveillance will reduce the number of operator-related accidents.

Box 3-A.—Selected State Audit Programs

Washington.—In Washington, carriers are targeted by the number of accidents during the past 3 years, the number of critical violations, and the number of hazardous materials violations.[1] During an audit, State officials examine records on hours of service, speeding violations, maintenance, and hazardous materials incidents. They also analyze accident reports and review the carrier's safety management system and its hiring practices for drivers. Eighty-nine audits were conducted between September 1985 and September 1987: of these, 20 were rated satisfactory, 51 were rated marginal, and 18 were rated unsatisfactory.[2]

Educating motor carriers about safety policies and requirements is an important component of Washington's program. Carriers are carefully monitored for 3 years to see if they maintain compliance with State standards. After 3 years of successful compliance, carriers are monitored less heavily but are still accountable to Motor Carrier Safety Assistance Program (MCSAP) authorities. Administrative sanctions are imposed if a carrier fails to bring its operations into compliance. State MCSAP officials found that the use of enforcement sanctions has reduced by 5 percent the number of carriers targeted for audits.

Oregon.—Oregon officials consider three factors when selecting carriers for audits: out-of-service violations greater than the industry average; complaints from industry members or the public about a particular carrier; and a carrier's preventable accidents. Audits performed in Oregon emphasize equipment inspections and the checking of daily logs or other time documents kept by drivers. Civil penalties are assessed for all out-of-service violations (except brake adjustment), and enforcement action is taken when drivers are found to be in violation of hours-of-service regulations after the first audit.[3]

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[1] Accident rates are often flat figures because interstate carriers do not report mileage statistics to Washington State authorities. Although carriers may be requested to submit mileage data, the reliability of the information received is questionable. Alan Scott, transportation operations manager, Washington Utility and Transportation Commission, personal communication, Sept. 25, 1987.

[2] Ibid.

[3] OTA research, 1987.

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[43] Robert L. Bleakley, Federal Highway Administration, personal communication, Oct. 10, 1987.

[44] *Maine Times*, "Losing Control: Deregulation May Have Made It Too Easy to Get Into the Trucking Business," May 8, 1987, p. 2.

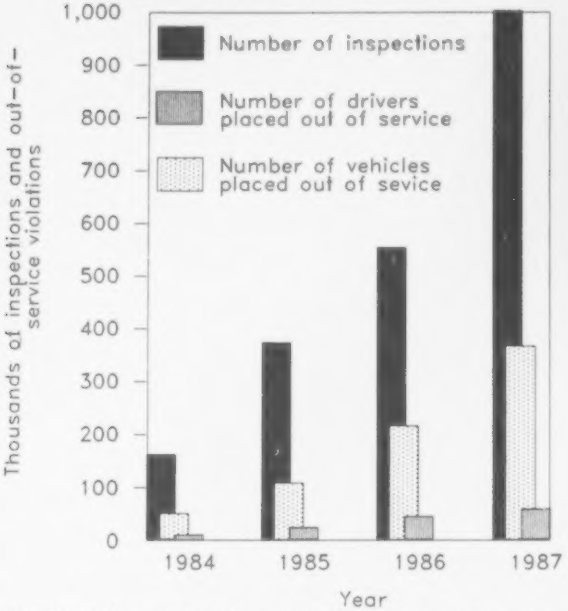
[45] Robert Hanley, "60% of Trucks Fail New York Area Inspections," *New York Times*, Oct. 8, 1986, p. B1.

[46] William Shaefer, coordinator, Motor Carrier Safety Assistance Program, Connecticut Department of Transportation, personal communication, July 22, 1987.

[47] OTA research, 1987.

[48] L.J. Nickerson, Idaho State Police Department, personal communication, July 21, 1987.

Figure 3-2.—Motor Carrier Inspections and Out-of-Service Violations, 1984-87



SOURCE: U.S. Congress, Senate Committee on Commerce, Science and Transportation, Motor Carrier Safety Assistance Program: Options Intended to Improve a Generally Successful and Cooperative Federal/State Partnership Promoting Truck and Bus Safety (Washington, DC: U.S. Government Printing Office, 1988), Table 3, p. 18.

Currently, human error accounts for over 60 percent of all commercial motor vehicle accidents (see chapters 4 and 6 for further information). Special efforts aimed at drivers have been instituted in a number of States. Nevada's "Driver Check" program has resulted in a 3.7-percent decline in accidents caused by driver error. Using a hardwired remote terminal connected to the State's mainframe computer, enforcement personnel at fixed locations can check local, regional, and interstate drivers. During these license checks, enforcement personnel can identify cases of suspension, revocation, outstanding warrants, and multiple licenses.[49] Tennessee has a special drug and alcohol enforcement program. Inspectors are taught to recognize probable cause for drugs and are equipped with manuals and a field test kit that help them identify paraphernalia and illegal drugs.[50]

Photo credit: Rhode Island State Police

Once a truck is placed out of service, appropriate repairs must be made before it can be driven again.

Buses

State officials also have the authority to inspect for-hire, interstate, and intrastate buses. (Private carriage of passengers is exempt from the Federal safety regulations.) Although all but 11 MCSAP States inspect buses, only a few devote a significant portion of their resources to bus inspection programs; more often, States conduct annual, terminal audits for buses registered in State. In Minnesota, for example, the State legislature mandates that all school buses must pass a terminal inspection each year.[51]

States that do conduct bus inspections usually inspect unloaded buses only. Inspectors focus on areas where a number of buses can be inspected at once, such as sports complexes, casinos, and amusement parks. This strategy is considered most efficient because passengers are not inconvenienced and companies usually have the time and resources to get a replacement if a bus is placed out of service. Michigan, for example, routinely inspects buses at Detroit's sports facilities; bus drivers are usually cooperative—as well as unaware of safety defects on their vehicles.[52]

Under MCSAP, New Jersey has developed a bus inspection team that targets both loaded and unloaded buses, many of them en route to Atlantic City. Of the 8,900 roadside inspections conducted between April 1987 and April 1988, 718 buses were

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[49] Federal Highway Administration, "Innovative MCSAP Programs," unpublished manuscript, July 25, 1987, p. 9.

[50] Ibid.

[51] Larry Klukow, Minnesota State Police, personal communication, May 27, 1988.

[52] William Murphy, Department of Motor Carriers, Michigan State Police, personal communication, Apr. 26, 1988.

Photo credit: California Department of Transportation

Photo credit: California Department of Transportation

Some States have special roadside inspection programs for buses. Brake and steering system deficiencies are frequent safety violations.

placed out of service. Officials have reported that since the roadside inspection program began, fewer buses have out-of-service violations.[53]

In California, the vast majority of buses receive annual, terminal inspections. However, State officials have also inspected loaded buses since they discovered that the "gamblers specials," offering tours to Reno or Las Vegas, Nevada, were often operating illegally and unsafely. Bus companies that advertised 24-hour turnaround operations appeared to be particularly hazardous, and officials discovered that drivers often violated hours-of-service regulations by staying with the tour the entire time. Several highly publicized bus accidents in California were attributed to driver fatigue. To bring these operations under control, State officials created a task force to develop a State roadside inspection program in 1981. Brakes, tires, and defective steering systems as well as driver violations are common safety problems.[54]

Commercial Vehicle Safety Alliance

To promote interstate cooperation and a more efficient motor carrier safety inspection system, agencies in 46 States and 10 Canadian provinces have agreed to adopt uniform truck inspection standards as members of the Commercial Vehicle Safety Alliance (CVSA). Formed in 1980 under the leadership of California, Idaho, Oregon, and Washington, CVSA is independent of the Federal Government, although FHWA now coordinates closely with CVSA in a major outreach effort.

CVSA is organized into four regions, each with its own elected officials who concentrate on local or regional issues. Special CVSA national committees address issues related to data collection, drivers, vehicles, research, training, and hazardous materials. Industry associations and companies are encouraged to express their concerns and to become nonvoting associate members of CVSA.

CVSA States and provinces use common inspection standards and out-of-service criteria developed in cooperation with DOT. In addition, members affix and recognize common inspection decals on trucks; the decals are valid for 3 months and indicate the quarter in which the last inspection took place. Vehicles that pass a CVSA North American Standard Inspection can usually pass through member States and provinces without further inspection, unless a readily visible defect is detected or a decal expires.

One reason CVSA was formed was to reduce delays caused by duplicative inspections of interstate vehicles; however, many factors undermine the effectiveness of the strategy to provide uniformity. Because only certain State agencies belong to the CVSA, other State agencies with power of enforce-

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[53] Sebastian Messina, chief of Motor Carrier Inspection and Investigation, Office of Regulatory Affairs, New Jersey Department of Transportation, personal communication, Apr. 27, 1988.

[54] Charles S. Allen, commander, Department of the California Highway Patrol, Motor Carrier Section, personal communication, May 2, 1988.

Photo credit: New York State Department of Transportation

Photo credit: New York State Department of Transportation

After examining a tanker for safety violations, an inspector applies a Commercial Vehicle Safety Alliance decal, good for three months. The decal is proof to inspectors in other CVSA member States that the truck has passed inspection and need not be rechecked.

ment or inspection sometimes refuse to recognize or issue the decals. In addition, inspectors will not give decals to trucks that pass inspections other than the North American Standard. Standards for issuing the inspection stickers have been inconsistent among the member agencies, though CVSA officials are working to resolve this through better communication.

Drivers complain that their trucks are subjected to additional inspections, sometimes as frequently as three times a month, causing costly and unnecessary delays. Independent drivers and owner-operators are particularly affected because their vehicles are not readily identifiable as belonging to a large fleet whose maintenance practices are known and respected by inspectors.[55] CVSA acknowledges startup problems and claims that the majority of complaints have been from drivers in the States that have recently joined CVSA and where personnel need experience with inspection procedures.[56]

Personnel and Training

State inspection forces vary in size and capability. A majority of States train some members of the highway patrol to be certified MCSAP inspectors. Civilians in a number of States are also empowered to enforce safety regulations and are trained to work with the officers. More ambitious States attempt to instruct most or all members of the highway patrol to recognize fundamental safety violations, usually brakes out of adjustment and hours-of-service violations. For the most part, however, instruction in truck safety is not provided at State police academies, and a limited number of enforcement personnel are responsible for conducting roadside inspections.

Unless a State has developed its own program, training is provided either by Federal officials or by instructors from the Training Safety Institute (TSI) in Oklahoma City. FHWA has divided MCSAP States into nine regions. The Federal employees in each region train inspectors in their States in cooperation with trainers from TSI. Usually two instructors train an average of 30 participants in 4 to 5 days. All State participants are taught to inspect vehicles and cargo and to check driver qualifications.[57] States that have developed notable training programs are highlighted in box 3-B.

Instruction provided for FHWA staff is more intensive than the courses offered to State participants, although by October 1988, training courses for State officials will cover the same material taught to Federal officials. FHWA trainees attend 5-week classes at TSI and learn to conduct safety reviews instead of inspections. Between June 1986 and June 1987, the Federal staff of safety specialists doubled when 150 Federal officials graduated from TSI.

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[55] Rita Bontz, president, Independent Truck Drivers Association, personal communication, Apr. 24, 1988.

[56] Russ Fiste, Commercial Vehicle Safety Alliance, personal communication, May 25, 1988.

[57] Robert L. Bleakley, Federal Highway Administration, personal communication, Nov. 11, 1987.

Since Federal support for training began in 1984, well over 4,000 State inspectors have been trained.[58] Few regions, however, have the resources to meet all training needs. For example, recently trained Federal investigators need additional hazardous materials training, and Federal officials who usually train State inspectors have redirected their efforts toward these employees.

Training officers are also unable to meet the demand for refresher courses in some regions. Although many inspectors receive on-the-job recur-

Box 3-B.—A Sample of State Training Programs

Michigan.—Michigan's training program is designed to instruct State officials, other than certified inspectors, in how to conduct a motor vehicle inspection. The 24-hour course emphasizes commercial vehicle safety standards, with instruction in hours-of-service and log record violations, driver qualifications, size and weight violations, driver licensing, and registration violations. Michigan officials are also creating a training videotape to be used by other States interested in duplicating the program.[1]

Oregon.—The Public Utility Commission of Oregon sponsors a 2-week training course about five times a year, with 18 students enrolled in each. To enroll, participants must have 1 week of driver and vehicle inspection experience with a qualified commercial vehicle inspector. The course curriculum includes in-depth training in safety regulations such as brake systems, vehicle out-of-service criteria, and hazardous materials regulations. In addition to in-State participants, trainees include officials from other States and from the Federal Highway Administration, as well as members of the trucking industry.[2]

Arizona.—Arizona has two training programs: a 6-week session for its motor carrier investigators and a 40-hour training program for State highway patrol officers. Each of the 30 motor carrier investigators authorized to enforce Federal safety regulations participates in an intensive 6-week training class taught by field training officers. Once trained, investigators conduct audits and work at ports of entry instead of enforcing regulations on the State highways. Enforcement on the highways is the responsiblity of the State patrol.

Highway patrol officers attend a 40-hour training program that emphasizes the driver. All officers are taught how to understand and enforce the hours-of-service regulations. Approximately half of Arizona's 460 officers have attended this course. Training is provided by 10 safety specialists, whose primary responsibility is roadside inspections and who respond to requests for other training courses in the State. Training was requested for city enforcement officials in Tucson and Phoenix last year, and both cities subsequently developed motorcycle squads dedicated to enforcing truck safety.

Arizona's motor carrier accident rate decreased 12 percent between 1985 and 1986, and officials attribute this decline to their substantial training and enforcement efforts. Although Arizona's safety record continues to improve, statistics indicate that after the initial impact of the State's programs, the accident rate may decline at a slower pace—the rate of decrease fell only 1 percent from 1986 to 1987.[3]

California.—The Highway Patrol Academy teaches a 2-week Commercial Enforcement Training Course with 48 hours of classroom instruction and 32 hours of field training. The classroom training includes lessons in size and weight enforcement, brake equipment laws, hazardous materials transportation regulations, commercial vehicle registration, inspection procedures, loading regulations, logbook requirements, and lighting laws. During the field training, participants are guided through the inspection process.

The course is taught at the academy four times a year, and in other areas of the State twice a year. A maximum of 24 students can participate (2 trainees per inspector). The academy is not federally funded. All graduates enforce motor carrier regulations on a full-time basis, so the number of enforcement officers in California continues to increase. Approximately 139 civilian inspectors and 296 uniformed personnel currently enforce the safety regulations.[4]

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[1] Daniel Folstad, Michigan Department of State Police, personal communication, Aug. 25, 1987.

[2] Paul R. Henry, deputy administrator, Transportation Safety Division, Public Utility Commission of Oregon, personal communication, Sept. 30, 1987.

[3] R.L. Hoffman, commander, Special Services Division, Arizona Department of Public Safety, personal communication, Oct. 13, 1987 and Aug. 16, 1988.

[4] Larry Blood, California Highway Patrol, personal communication, Nov. 6, 1987.

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[58] William Nalley, Federal Highway Administration, personal communication, Nov. 3, 1987.

rent training, changing procedures and regulations necessitate refresher courses. Regional officials stressed that, in particular, they lack the capability to provide additional hazardous materials courses.

Recognizing that uniform training is an essential basis for consistent commercial vehicle inspections, CVSA, FHWA, and TSI have combined efforts to standardize training courses. In June 1986, a DOT/State training committee was formed to recommend ways to standardize hazardous materials and vehicle inspection training. Members agreed that both course content and instructors should be certified, training should be accomplished at a local level, refresher training should be conducted annually, and a train-the-trainer program should be created. Many of these recommendations, such as the train-the-trainer program, are being implemented, although budget and time constraints hamper efforts. In some States, instructors have been told to condense their training and teach the same course in only a few hours. Nevertheless, TSI trainers expect that the number of certified commercial vehicle inspectors should increase significantly as a result of the program.[59]

Recognizing the need for more trained State personnel, CVSA, FHWA, and TSI are cooperating to create a new training package with several levels of training. FHWA contracted with Michigan to complete the package by May 1, 1988; CVSA supervised the project; and members of TSI are incorporating hazardous materials training and will keep material up-to-date. The package includes four courses:

- Full Inspection.—This duplicates the North American Standard Inspection course currently taught.
- Walk Around Vehicle Inspection.—This course is geared towards highway patrol officers who have many additional responsibilites. Michigan is currently reviewing the results of a pilot study conducted last spring, when 125 of their patrol officers were given a day and half of training in motor carrier safety. Although lack of time limited their ability to enforce safety regulations, most participants felt they benefited from the course.
- Driver Inspection.—This driver-only course was developed partly in response to the commercial driver's license law and partly because so much evidence indicates that the majority of motor carrier accidents are the fault of the driver.
- Special Road Inspection.—This is a course for special inspections that focus on either a type of truck (i.e., cargo tanks) or one aspect of trucks (i.e., brakes).[60]

The course package has been submitted to DOT for review and assimilation into MCSAP procedures. Current FHWA plans call for States to dedicate 75 percent of enforcement time to the full inspection course, and 25 percent to the others.

The new training package and the train-the-trainer program are also intended to increase each State's role in roadside inspections. State officials are now encouraged to attend the MCSAP management course at TSI, a course previously limited to Federal employees. Although regional Federal instructors will continue to train State inspectors, the train-the-trainer courses and the MCSAP management course allow for more State control over roadside inspections; Federal officials will focus on audits and safety reviews.

Enforcement Issues

State officials agree that placing a vehicle out of service is the enforcement measure most likely to deter drivers and carriers from violating safety regulations. Most officials have also been responsive to the efforts of CVSA and FHWA to create uniform inspection standards and have adopted the Federal out-of-service criteria.[61] However, State officials acknowledge that personnel limits hamper effective enforcement, and admit that modified inspection procedures and inspection stickers may be necessary to permit more motor carrier inspections and ease the burden on industry posed by multiple inspections.

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[59] Frank Tupper, Training Safety Institute, personal communication, Nov. 2, 1987.

[60] Commercial Vehicle Safety Alliance, "Bylaws and Memorandum of Understanding," unpublished manuscript, October 1986. These inspection levels were adopted at the Commercial Vehicle Safety Alliance annual meeting at Bar Harbor, ME, Oct. 24, 1986.

[61] Taken from an informal telephone survey of 45 States conducted by the Office of Technology Assessment in October 1987. Unless otherwise noted, information given in this section is derived from this survey.

Carriers claim, and OTA research confirms that uniform inspections are still the exception rather than the rule—enforcement measures vary among and within States, creating many uncertainties for carriers. For example, enforcement strategies for vehicles that violate safety regulations but do not meet the out-of-service criteria vary. In some States, a fine is issued for each violation. In others, the driver is given an inspection form that must be completed by the carrier, usually within 15 to 30 days, and returned to the enforcement agency when repairs have been made. The most stringent States do both. A driver stopped for any inspection, however, loses precious time needed for load delivery within his deadline, regardless of whether violations are found or penalities imposed.

Classifications of safety violations also vary. In many States, the enforcement officer will cite an offender for either a criminal or civil offense, depending on the severity of the violation. Fines and penalties for similar violations often differ, not only from State-to-State, but by jurisdictions, as well. To increase uniformity of penalties, several States now classify motor carrier safety violations as civil penalties with set fines consistent within a State unless contested by the offender. However, enforcement officials in a number of States claim that offenders who protest tickets are too often rewarded for their efforts. They argue that judges and magistrates are not only inconsistent in their deliberations, but often uninformed about the gravity of safety violations and lenient with violators. For example, in Maryland, drivers with out-of-service violations theoretically can receive $1,000 fines, but fines are often significantly reduced at the judicial level. Moreover, Maryland law prohibits State patrol officers from fining trucks more than $30 for routine violations, and some drivers and carriers consider this just a cost of doing business in Maryland. Other States also find that low fines are not effective deterrents to safety violations.

In particular, officials report, judges do not appear to understand the safety implications of weight limit violations, viewing them as minor offenses. In Maine, for example, some judges consistently dismiss charges for overweight vehicles, despite a State statute that sets penalties for these offenses. In some counties in Kansas, officers have stopped citing drivers for excessive cargo because judges invariably refuse to fine them.

State officials complain that lack of change at the legislative level hinders improvements in the judicial system. In Ohio, fines have not increased since 1923.[62] Safety officials also complain that legislators place little priority on safety and are reluctant to limit judicial authority by establishing statutes for safety violations. Enforcement efforts are further undermined by lack of communication between judicial and enforcement officials, between members of the trucking industry and enforcement agencies, and between enforcement agencies in the same State. In some States where the Public Utilities Com-

Photo credit: Commercial Vehicle Safety Alliance

Penalties for safety violations may vary widely by jurisdiction or, in some States, by officer discretion.

Photo credit: Rhode Island State Police

Temporary scales are used to check compliance with truck weight limits at some roadside inspection sites.

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[62] David Leland and staff, Public Utilities Commission of Ohio, "Ohio Transportation Regulation: Back to the Future," unpublished manuscript, 1987, p. 28.

mission has been designated the lead agency, its employees do not work closely with officers from the highway patrol and are unfamiliar with the enforcement efforts of the State police.

A number of State enforcement agencies have begun educating legal officials themselves. In West Virginia, for example, a State supervisor meets with local legal officials to explain which violations should be considered most serious before inspections are conducted at a new site. The Department of Safety in Missouri sponsors annual seminars on truck safety for judges in the St. Louis area, and is considering expanding this program to other regions of the State. In Idaho and Ohio, a legal attorney has been hired to assist State prosecutors and judges in cases of violations of motor carrier safety regulations. At a recent conference in Tucson, Arizona, truck safety specialists were given their first opportunity to address State judges. In Rhode Island, the arresting officer must be present at the hearing to explain the circumstances and potential hazards of a safety violation to the judicial authority.

Some officials feel that education should be aimed at the drivers, especially in States where Federal safety regulations have been most recently adopted. Delaware sponsored two seminars for members of the industry this year, hoping not only to educate truckers, but also to improve the relationship between enforcement officers and drivers. In New Hampshire, the Department of Safety organizes informal coffee breaks at truck stops to try to increase driver understanding of the Federal regulations and what to expect at roadside inspections. California has a well-established public information campaign that includes presentations to trucking companies as well as efforts to establish a better rapport between truck drivers and members of the California Highway Patrol.

Difficulty identifying carriers and drivers with multiple violations is yet another impediment to effective enforcement. Although most States keep records of driver and vehicle violations, few have the capability to identify repeat offenders. In smaller States, name recognition is used to pinpoint carriers with safety records. Rhode Island has begun fining carriers instead of drivers for economic violations to target carriers cited for multiple violations,[63] and can now identify carriers that repeatedly incur or neglect to pay fines. This policy developed when officials decided that responsibility for vehicle maintenance rested with the carrier instead of the driver. One goal is to encourage drivers to alert enforcement officials voluntarily when forced to drive trucks that violate equipment regulations.

Arizona adopted civil penalties in 1986 to target repeat offenders. Multiple or hazardous materials violations are automatically subject to higher fines. If a motor carrier is guilty of repeated violations after being informed of noncompliance, the carrier's operating license is suspended.

California's new computerized Management Information System of Terminal Evaluation Records contains carrier fleet information, hazardous materials spills, license history, citation information, accident involvement, and terminal ratings. This system identifies carriers and drivers with particularly poor safety records, and after its first year of operation, officials discovered that some carriers had received between 600 and 800 citations.[64] When SAFETYNET becomes operational, this type of information will be accessible nationwide.

In Maryland a special enforcement team, the Bus and Truck Patrol, has been created to increase bus and truck compliance with safety regulations.[65] This seven-person team is dispatched to one area for 1 to 6 months. Plainclothes officers, who are certified MCSAP inspectors using unmarked cars, try to reduce the number of moving violations, such as speeding and tailgating; they can place trucks out of service, if necessary.

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[63] William A. Maloney, associate administrator of Motor Carriers, Rhode Island Division of Public Utilities and Carriers, personal communication, Aug. 4, 1987.

[64] Phyllis Myers, California Highway Patrol, personal communication, Nov. 11, 1987.

[65] Millard M. Bell, supervisor, Special Traffic Enforcement, Maryland State Police, personal communication, Oct. 8, 1987.

CONCLUSIONS AND POLICY OPTIONS

A comprehensive national truck safety program requires continuing emphasis on programs developed over the last 5 years and a more systematic Federal-State approach. **OTA concludes that the top priorities are: 1) improving State enforcement capabilities, 2) increasing State regulatory uniformity, and 3) better coordination and cooperation among agencies within DOT at the Federal level.** Congressional mandates and DOT actions since 1980, such as requirements for vehicle inspections and national standards for driver licensing, can make major contributions to highway safety if uniformly applied.

MCSAP has firmly established the role of States as an essential adjunct to Federal highway safety efforts. **OTA concludes that continued Federal financial support at current levels for State inspection and enforcement activities through MCSAP is crucial. Additional trained personnel are needed across the country.** Monitoring industry, through State terminal audits and ensuring the safety fitness of all motor carriers, is an important component of a systematic safety program. Because State audit programs are such valuable additions to Federal enforcement efforts, FHWA could be required to develop guidelines and handbooks for States to encourage more States to train inspectors and begin auditing carriers. Efforts undertaken by FHWA to improve regulatory compliance materials for industry would be helpful for the States as well.

OTA concludes that industry complaints about inconsistent State inspection and enforcement procedures and penalties are symptoms of the need for stronger Federal-State cooperation for national uniformity. CVSA's goal of establishing uniform inspection and out-of-service criteria provides an excellent model for States to use in working together toward consistent nationwide programs. However, any efforts will be ineffective unless States make the commitment to have their executive agencies cooperate toward this goal. To help resolve conflicts in State agency agendas, strong DOT support for consistent enforcement programs will be needed, once FHWA's review and evaluation of State laws and regulations has been completed. Cooperative efforts with State officials and bar associations are key. State executive agencies, legislative bodies, and law enforcement organizations may accept the need for uniformity more readily if they are involved and informed at an early stage. **Congress may wish to consider requiring DOT to provide technical assistance and technology transfer for additional educational materials for State officials, law enforcement personnel, and judges.** An enforcement handbook providing general guidance on the safety regulations and safety factors to consider when setting penalty amounts for various types of violations could be helpful.

In the Motor Carrier Act of 1984, Congress made clear that decisions on access to State roads for large trucks are the province of the States. However, States have found developing routes and communicating access decisions clearly to industry to be complex and difficult tasks, requiring hard work, patience, good will, and good humor from all parties. Where this process has failed, carriers travel on the routes they deem necessary to reach their destinations, often traveling small rural or urban roads in violation of State law and endangering themselves and other motorists.

OTA concludes that varying State access, inspection, and enforcement policies pose significant problems for industry. A national truck safety program should apply equivalent safety requirements to all heavy trucks. This implies that no exemptions to the commercial driver's license are warranted. Congress may wish to encourage States to develop more uniform safety requirements. Congress may also wish to consider eliminating all exemptions from Federal truck safety regulations and encouraging DOT to play a more active and assertive role in facilitating State/industry dialog and resolving difficult access issues. Technology transfer of innovative approaches and working actively with appropriate State and industry organizations are two possible approaches. For further discussion of the technical aspects of the access issue, see chapter 5.

Finally OTA finds that the division of responsibility for different aspects of roadway, vehicle, and driver issues among multiple agencies hampers safety problem solving at DOT. The extent to which DOT will be able to respond effectively to congressional safety directives depends on better cooperation and more systematic coordination among Federal agencies. For example, better accident data analysis at NHTSA could provide information to the Office of Motor Carriers for driver training guidelines or hours-of-service rules. Information about vehicle characteristics and design standards could be exchanged by NHTSA and FHWA to guide program development.

Congress may wish to require DOT to develop a plan to integrate the technical expertise now divided between NHTSA and the motor carrier and highway design sections of FHWA to address issues such as roadway and vehicle compatibility guidelines, upgraded safety equipment standards, national guidelines for training for maintenance personnel and drivers, and accident reduction and mitigation strategies. The approach that DOT has taken to developing the commercial driver's license program is commendable; it could serve as a model for efforts to deal with equipment requirements and highway design issues.

OTA further concludes that DOT agencies need to cooperate and coordinate in collecting and analyzing data, conducting research programs, and developing regulatory proposals. Establishing special work groups to address issues of common concern, jointly funding research activities, and sharing staff expertise are examples of strategies that could bring benefits at little or no extra cost.

Additional DOT technical assistance for State agencies in developing more uniform data management systems and analytical capabilities, especially in tracking preventable accidents and violation statistics, would be an effective use of limited funding. States could use this information to target carriers for audits and inspections. As FHWA and ICC implement new procedures for assessing the safety fitness of commercial vehicle operators, explicit procedures for monitoring ongoing safety performance will be needed. State personnel and FHWA field inspectors alike could benefit from consistent guidelines for deciding whether to initiate a compliance education program or an enforcement action. Improved educational materials on Federal safety requirements that could be distributed to States and motor carriers on model programs for amending laws, implementing Federal standards, and developing an information clearinghouse would also be extremely useful.

APPENDIX 3-A: CHRONOLOGY OF FEDERAL LEGISLATION RELATING TO THE MOTOR CARRIER INDUSTRY (1935-87)

1935—**Motor Carrier Act.** Formally regulated the motor carrier industry by authorizing the Interstate Commerce Commission (ICC) to regulate common, contract, and private carriers engaged in interstate or foreign commerce. Granted ICC authority to establish requirements for employee qualifications and hours of service, and safety standards for operation and equipment.

1944—**Federal-Aid Highway Act.**[1] Authorized the designation of a 40,000-mile system of highways, now known as the Interstate Highway System.

1948—**Reed Bulwinkle Act.** Granted Rate Bureaus immunity from antitrust laws, promoting joint service arrangements between competing carriers. Information about rates and classifications, published by Rate Bureaus, were also used by carriers and shippers to negotiate individual rates.

1956—**Highway Trust Fund.** Established a fund comprised of proceeds from Federal motor vehicle fuel taxes and various excise taxes to finance construction of all Federal-aid highways.

1966—**Highway Safety Act.** Directed the Secretary of Commerce to issue standards for driver education and licensing; vehicle registration, operations, and inspections; accident investigations and reporting; and traffic control, highway design, and maintenance. Required States to establish highway safety programs in accordance with these Federal standards and match Federal funds received. Directed the Department of Commerce to expand highway safety research and development activities.

1966—**National Traffic and Motor Vehicle Safety Act.** Mandated the development of minimum manufacturing standards for motor vehicles, Required a new agency, the National Traffic Safety Agency, to issue safety standards for passenger automobiles, trucks, buses, and motorcycles; to conduct research, testing, development, and training necessary to reduce traffic accidents and related deaths and injuries; and to expand the National Driver Register to identify individuals whose motor vehicle operating licenses had been denied, terminated, or temporarily withdrawn. Prohibited ICC from adopting or continuing safety standards for motor vehicles under its jurisdiction that differed from the standards established under this act.

1966—**Department of Transportation Act.** Transferred safety responsibilities of ICC and the Department of Commerce to the Department of Transportation (DOT). Internal agencies created included the Federal Highway Administration (FHWA), the National Highway Safety Bureau, and the National Traffic Safety Bureau.

1968—**Federal-Aid Highway Act.** Required DOT to establish national bridge inspection standards and a program designed to train employees to carry out bridge inspections.

1970—**Federal-Aid Highway Act.** Created an internal DOT agency, the National Highway Traffic Safety Administration (NHTSA), to carry out highway safety programs; research and development relating to highway safety, traffic construction and maintenance, traffic control devices, identification and surveillance of accident locations, and highway-related aspects of pedestrian safety. Authorized the creation of a special bridge replacement program.

1973—**Federal-Aid Highway Act.** Authorized funding for highway safety construction programs to reduce roadway hazards such as rail-highway crossings and improve highway engineering standards. Authorized the establishment of a pavement-marking demonstration project to provide greater vehicle and pedestrian safety. Directed DOT to carry out research on drug use and driver behavior and to investigate the use of mass media for informing and educating the public of ways and means for reducing the number and severity of highway accidents.

1975—**Hazardous Materials Transportation Act.** Authorized DOT to set regulations applicable to all modes of transportation.

1976—**Federal-Aid Highway Act.** Authorized funding for bridge reconstruction and development, and for eliminating hazards of railway crossings. Authorized DOT to provide incentive grants to States that had signficantly reduced traffic fatalities and to penalize States with weak safety programs.

1978—**Surface Transportation Assistance Act.** Authorized funds for highway construction. Directed DOT to inventory penalties for weight violations in each State, and required each State to report weight violation penalties annually to DOT. Authorized the establishment of a bridge replacement and rehabilitation program. Appropriated funds to NHTSA and FHWA for safety programs and to carry out highway safety research and development.

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[1] Federal-Aid Highway Acts 1954, 1956, 1958, 1960, 1962, 1964, 1966, 1974, 1981, and 1982 are not detailed in this appendix; the acts primarily authorized funds for highway construction.

1980—**Motor Carrier Act.** Directed ICC to relax standards for entry into the industry. Established that common and contract carriers needed to show only that they were fit, willing, and able. Expanded the private carrier exemption to allow intercorporate hauling between a parent company and its subsidiaries. Required owner-operators to meet the fitness test only if they haul specified processed food and other commodities and the owner is in the truck during the trip.

1982—**Bus Regulatory Reform Act.** Duplicated the motor carrier act of 1980 for the bus industry by relaxing standards for entry.

1982—**Surface Transportation Assistance Act (STAA).** Authorized and financed higher levels of Federal expenditures by raising and restructuring highway taxes. Established uniform truck weight, length, and width limitations for the Nation's highways. Established a new Federal grant program, the Motor Carrier Safety Assistance Program, to improve State capabilities to conduct inspections of vehicles and enforce motor carrier safety regulations.

1984—**Motor Carrier Safety Act.** Directed DOT to promulgate revised Federal regulations, establish fitness standards for commercial motor carriers, and undertake a 5-year review of State motor carrier laws to identify those that are more or less stringent than Federal requirements.

1984—**Tandem Truck Safety Act.** Allowed State Governors to seek exemptions for Interstate highway segments that could not safely accommodate trucks; modified reasonable access provision of the STAA to include 28-foot by 102-inch trailer units.

1986—**Commercial Motor Carrier Safety Act.** Established a new driver's licensing program that prohibits operators of commercial motor vehicles from holding more than one State license and requires drivers to pass a written examination and a road test in a vehicle that is representative of the type that will be operated.

1987—**Surface Transportation and Uniform Relocation Assistance Act.** Authorized funds for the construction of highways and for mass transportation programs. Directed DOT to establish a national bridge inspection program. Appropriated funds to NHTSA for purposes of research and development in highway safety.

APPENDIX 3-B: THE HISTORICAL FRAMEWORK

Although Federal regulation of motor carriers did not begin until 1935, many States enacted legislation in the 1920s governing various aspects of truck and bus transportation, including economic operations, highway protection, and safety.[1] Led by Texas, a number of States established regulatory programs for both common and contract carriers. Requirements for contract carriers, generally less extensive than those for common carriers, were imposed to protect the operations of common carriers.[2] Interstate carriers were not generally subject to State economic regulations; however, several Supreme Court decisions upheld the application of State safety and highway requirements to interstate carriers.[3]

The absence of Federal control over interstate carriers encouraged intense competition within the motor carrier industry. Finally, with the support of the railroads and the large, established trucking companies, Federal legislation governing commercial motor carriers was passed in 1935.[4] The Motor Carrier Act of 1935 authorized the Interstate Commerce Commission (ICC) to regulate motor carriers engaged in interstate or foreign commerce. The authority extended to intrastate operators handling shipments moving in interstate and foreign commerce.[5] Three major categories of motor carriers were addressed by the act:

- Common carriers—for-hire carriers holding themselves out to serve the public;
- Contract carriers—for-hire carriers operating under special contracts, usually for shipments over a specified period of time; and
- Private carriers—carriers transporting goods for their own use or uses incidental to their businesses.

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[1] By 1932, all States except Delaware had attempted to regulate the transportation of passengers, and 29 States had laws controlling the carriage of property by motor vehicles. Philip D. Locklin, *Economics of Transportation* (Homewood, IL: Richard D. Irwin, Inc., 1972), pp. 673-674.

[2] The Texas law required contract carriers to obtain permits, while common carriers were issued certificates of public convenience and necessity. In addition, minimum rates for contract carriers, which could not be lower than railroad rates, were prescribed. It should also be noted that earlier attempts by States to regulate contract carriers were struck down by the U.S. Supreme Court, because they were not found to be businesses providing services with a public interest. Ibid., p. 675.

[3] State control over interstate carriers was invalidated by a 1925 Supreme Court decision that ruled that States could not forbid, limit, or prohibit competition in interstate commerce. See Buck v. Kuykendall, 267 U.S. 307 (1925).

[4] Public Law No. 255, 49 Stat. 543 (1935).

[5] While the original act permitted such intrastate operators to transport persons or property within the State under State authorization, a 1962 amendment to the act eliminated the ability of intrastate carriers to engage in interstate commerce. Locklin, op. cit., footnote 1, p. 676.

In addition, requirements for transportation brokers were included.[6]

The Motor Carrier Act of 1935 also authorized ICC to establish requirements for driver qualifications and hours of service, and safety standards for operations and equipment. The first set of regulations, issued by ICC in 1940, applied to all common, contract, and private carriers.

The Federal-Aid Highway Act of 1944 authorized the Interstate Highway System—eventually to total over 42,000 miles—to connect metropolitan areas, serve the national defense, and link U.S. highways with major routes in Canada and Mexico. In 1956, Congress established the Highway Trust Fund, composed of proceeds from Federal motor vehicle fuel taxes and various other excise taxes, to finance construction of all Federal-aid highways, including the Interstate Highway System. Highway funds could be withheld from States that allowed trucks on the Interstate system with more than 18,000 pounds on a single axle, 32,000 pounds on a tandem axle, and 73,280 pounds gross vehicle weight (GVW). (In 1975, the maximum GVW limit was raised to 80,000 pounds.) However, under a grandfather clause, States could retain limits allowing wider or heavier vehicles that were in effect as of July 1, 1956. Moreover, each State was permitted to set different size and weight standards for other highways within its jurisdiction.

As the Nation's dependence on motor vehicles for personal and commercial uses grew, so did the number of serious accidents and fatalities. In 1965 alone, 49,000 persons were killed in highway accidents, 1.5 million suffered disabling injuries, and the economic costs associated with these accidents came to an estimated $8.5 billion.[7] To address these problems, Congress took a series of steps to improve highway safety.

The Highway Safety Act of 1966 directed the Secretary of Commerce to issue standards for driver education and licensing; vehicle registration, operations, and inspections; accident investigations and reporting; traffic control; and highway design and maintenance.[8] States were required to establish highway safety programs in accordance with these Federal standards and to match Federal funds received. States that did not implement safety programs were subject to a 10-percent reduction in their Federal highway funds. By 1970, all 50 States, the District of Columbia, and 4 territories had established highway safety programs.[9]

Concerned about the automobile industry's emphasis on style and performance instead of safety and collision protection, Congress also passed the National Traffic and Motor Vehicle Safety Act in 1966.[10] Under this act, a new agency within the Department of Commerce—the National Traffic Safety Agency—was empowered to issue safety standards for passenger automobiles, trucks, buses, and motorcycles; conduct research, testing, development, and training necessary to reduce traffic accidents and related deaths and injuries; and expand the National Driver Register to identify individuals whose motor vehicle operating licenses had been denied, terminated, or temporarily withdrawn.[11] Although State motor vehicle equipment standards had to be identical to the Federal regulations, stricter standards could be imposed for those vehicles procured by States or the Federal Government.

Shortly after safety statutes were enacted in 1966, Congress authorized the establishment of a Federal transportation agency—the Department of Transportation (DOT).[12] While the ICC retained economic regulatory authority over motor carriers, its safety responsibilities and those assigned to the Department of Commerce were transferred to DOT. Within DOT, the Federal Highway Administration was created to administer the regulatory programs related to employee qualifications and hours of service as well as to highway transportation operations and equipment safety. Separate agencies—the National Highway Safety Bureau and the National Traffic Safety Board—were formed to implement the provisions of the new safety laws. In addition, the National Transportation Safety Board was established to: 1) determine and report on the cause or probable cause of transportation accidents, 2) conduct special studies on transportation safety and accident prevention, and 3) make regulatory recommendations to the Secretary of Transportation.[13]

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[6] Brokers were required to obtain Interstate Commerce Commission licenses and bonds or other security. In addition, the Commission was authorized to specify accounting and recordkeeping requirements.

[7] Senate Public Works Committee Report 1302 to accompany S. 3052, Highway Safety Act of 1966 (June 23, 1966).

[8] Public Law 89-564, 80 Stat. 731 (Sept. 9, 1966).

[9] Insurance Institute for Highway Safety, *Status Report*, vol. 21, No. 11, Sept. 9, 1986.

[10] Public Law 89-563, 80 Stat. 718 (Sept. 9, 1966).

[11] The National Driver Register, originally established in 1960 by the Department of Commerce, was a voluntary driver record exchange program. Although all States participated in the program, the program provided only summary reports of license suspensions or revocations related to drunk driving or fatal accidents. The 1966 amendments allowed States to file reports on license denials and withdrawls for any reason, except for withdrawls of less than 6 months based on an accumulation of minor violations. Senate Commerce Committee Report 1301 to accompany S. 3005, National Traffic and Motor Vehicle Safety Act of 1966, June 23, 1966.

[12] U.S. Department of Transportation Act, Public Law 89-670, 49 U.S.C. 1651.

[13] In 1974, the National Transportation Safety Board became an independent agency and its role was expanded.

Chapter 4

Motor Carrier Accident Analysis

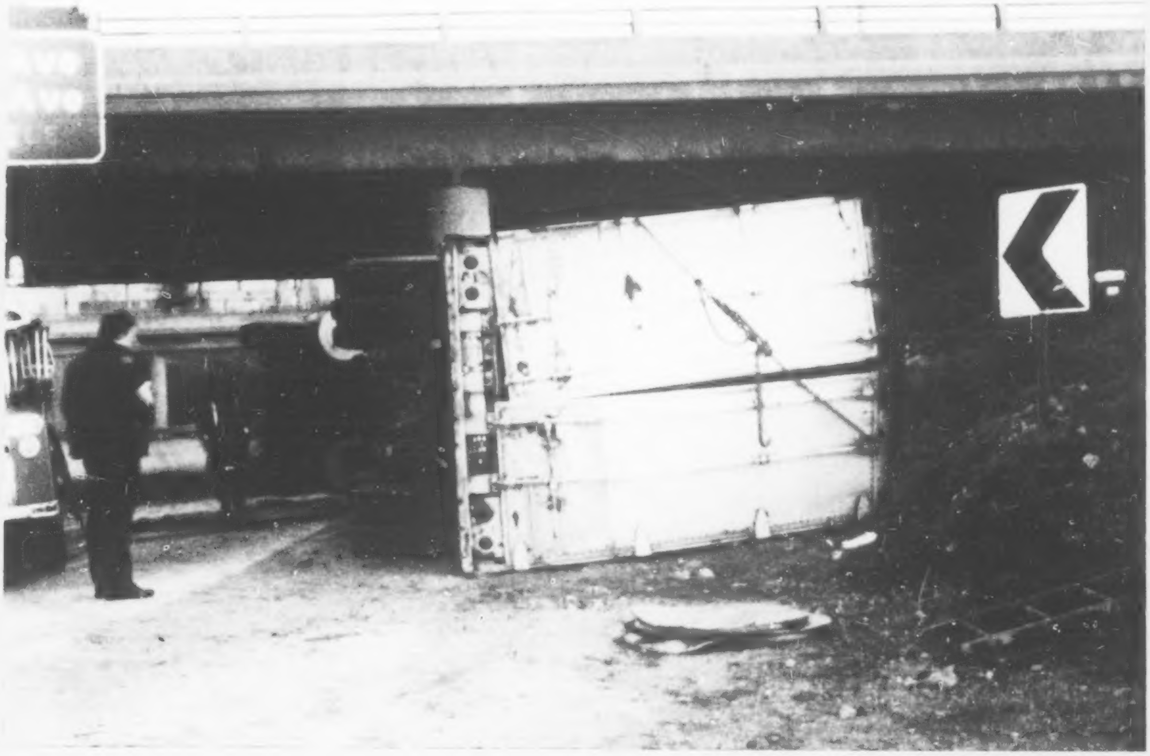

Photo credit: Ohio State Police

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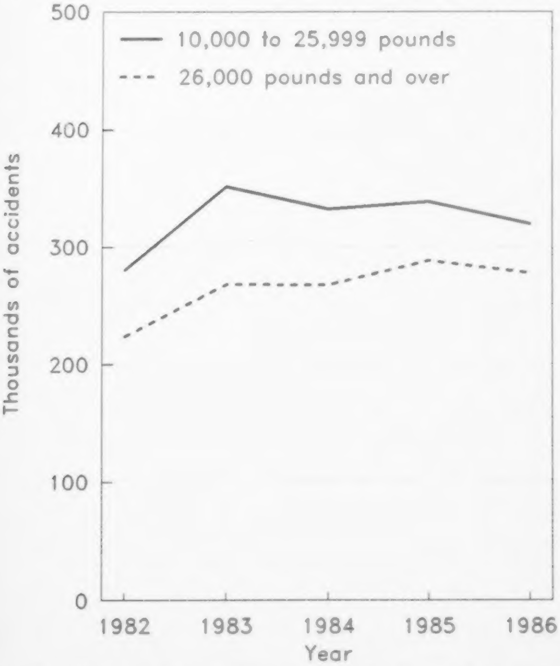
Chapter 4

Motor Carrier Accident Analysis

Accidents for heavy trucks (those with a gross vehicle weight rating of over 26,000 pounds) have increased over the last few years, reaching an estimated total of 278,322 accidents nationwide in 1986. (See figure 4-1.) Accidents for all trucks over 10,000 pounds increased at a slightly lower rate. Bus accidents are such a relatively small part of total accidents that accurate comparisons are difficult. Total truck-miles traveled also have risen during the 1980s, but somewhat less than the rise in heavy truck accidents.[1]

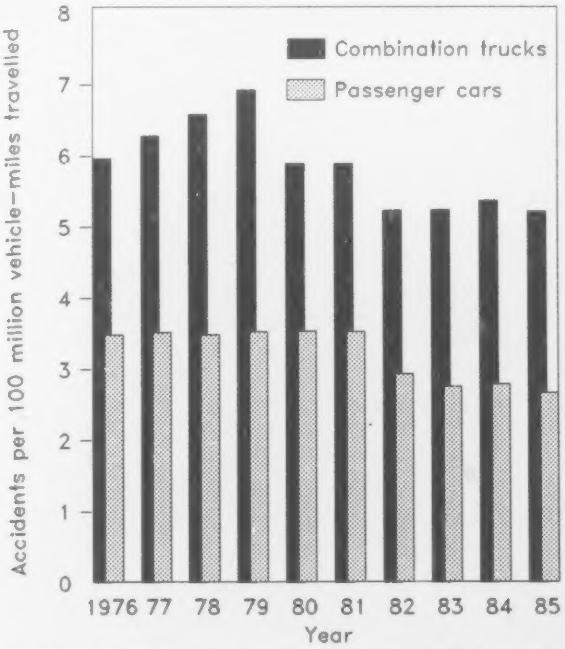
Of all heavy vehicles, tractor-trailer combinations provide the most difficult driving challenges, and the severity of the accidents in which they are involved reflects their special nature. Roughly 1 to 2 percent of these accidents result in a fatality[2]—about double the percentage for automobiles (see figure 4-2). The comparable figure for all other types of motor vehicles (except motorcycles) is well under 1 percent. In the past decade, the average annual death toll from tractor-trailer accidents has ranged between 4,000 and 5,000 fatalities (see figure 4-3), increasing slightly since 1982. About 80 percent of the fatalities in these accidents were pedestrians or occupants of other vehicles, a proportion that has increased gradually over time (see figure 4-2). When single-vehicle truck accidents are eliminated, this proportion is even greater (see table 4-1). Head-on collisions are particularly severe. They

Figure 4-1.—Truck Accidents by Category of Truck



SOURCE: Office of Technology Assessment, 1988; based on National Accident Sampling System data.

Figure 4-2.—Vehicles Involved in Fatal Accidents



SOURCE: Office of Technology Assessment, 1988; based on Fatal Accident Reporting System data.

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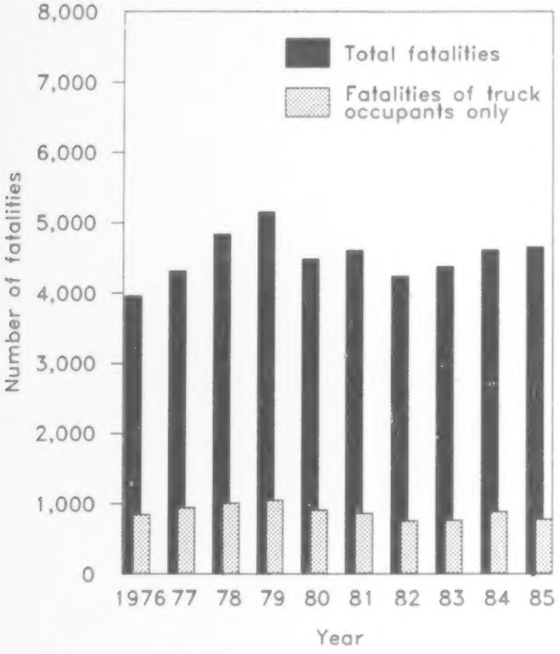
[1] OTA estimates from the National Accident Sampling System database; also National Highway Traffic Safety Administration calculations. California officials reported a similar rise over this period. See California Highway Patrol and State of California Public Utilities Commission, *Joint Legislative Report on Truck Safety*, AB-2678, Final Report (San Francisco, CA: November 1987), p. 19.

[2] Based on the National Accident Sampling System (1981-85) estimates. Multiple-vehicle accidents comprise 66 percent of all heavy truck accidents and 72 percent of all heavy truck accidents involving a fatality.

Figure 4-3.—Fatalities in Combination Truck Crashes



SOURCE: Office of Technology Assessment, 1988; based on Fatal Accident Reporting System data.

constitute only 3.3 percent of heavy truck accidents yet account for 29 percent of all fatal accidents involving those trucks.[3]

This chapter contains results from OTA's analysis of motor carrier accident data and a review of previous studies of three key accident causal factors: driver performance, vehicle factors, and the roadway environment. Areas needing further research are outlined, and policy options are identified that address accident causes as part of a national motor carrier safety strategy.

Table 4-1.—Car Occupant Deaths Compared to Truck Occupant Deaths in Fatal Crashes of Large Trucks and Cars

Year	Ratio of car occupant fatalities to truck occupant fatalities
1977	26:1
1978	28:1
1979	29:1
1980	31:1
1981	34:1
1982	28:1
1983	34:1
1984	35:1

SOURCE: Insurance Institute for Highway Safety, *Big Trucks*, 1985, p. 6.

METHODOLOGY

Thorough accident analysis requires accurately identifying the type of heavy vehicle involved, the roadway conditions, and, to the extent possible, the characteristics of the driver. However, determining all events leading to an accident is difficult because of the quality of available databases.[4] Police and insurance claim reports, the most common sources of information, are limited in detail, because the report forms ask for only certain information and investigating officers often do not adequately understand accident causation. The accident cause reported on the form is usually only the last event in a chain that includes interactions between the driver, vehicle, and highway environment as well as weather and location.

Exploring accident information beyond the detail in accident reports is of critical importance. When reporting accidents, police often must attribute responsibility to one of the parties, and if the accident cause is not clear, the mishap may simply be ascribed to driver error. Thus, the heavy vehicle driver may be blamed more frequently than warranted.[5] For example, in California, accident reports associate driver error with over 90 percent of truck-at-fault accidents.[6] In contrast, European data indicate multiple causes involving driver error and defects in road design and the vehicle in a majority of cases.[7] OTA research indicates that while human error is the primary cause of about 65 percent of accidents, other factors also contribute to most accidents.

---

[3] Based on National Accident Sampling System (1981-85) and Federal Accident Reporting System (1983) data. For further discussion of the strengths and weaknesses of these databases, see ch. 7.

[4] One of the earliest systematic studies of the interactions in accidents examined five major factors: human, environmental, vehicular, loss-limiting, and legal and regulatory. A.D. Little, Inc., *The State of the Art of Traffic Safety* (Boston, MA: June 1966).

[5] Kenneth Perchonok, "Driver and Vehicle Characteristics as Related to the Precipitation of Accidents," U.S. Department of Transportation, National Highway Traffic Safety Administration, Report No. DOT-HS-802 355, May 1977; and P.P. Jovanis, "A Perspective on Motor Carrier Safety Issues in the 1980's," presented at the Conference on Truck Safety, Northwestern University, June 1987.

[6] California Highway Patrol, op. cit., footnote 1, p. 10.

Combining accident and exposure data can clarify the relative importance of vehicle, driver, and environmental factors. Where appropriate, OTA used the Truck Inventory and Use Survey, the Federal Highway Administration (FHWA) monitoring program, and other survey instruments to estimate exposure. The quality and limitations of this information are discussed in chapter 7.

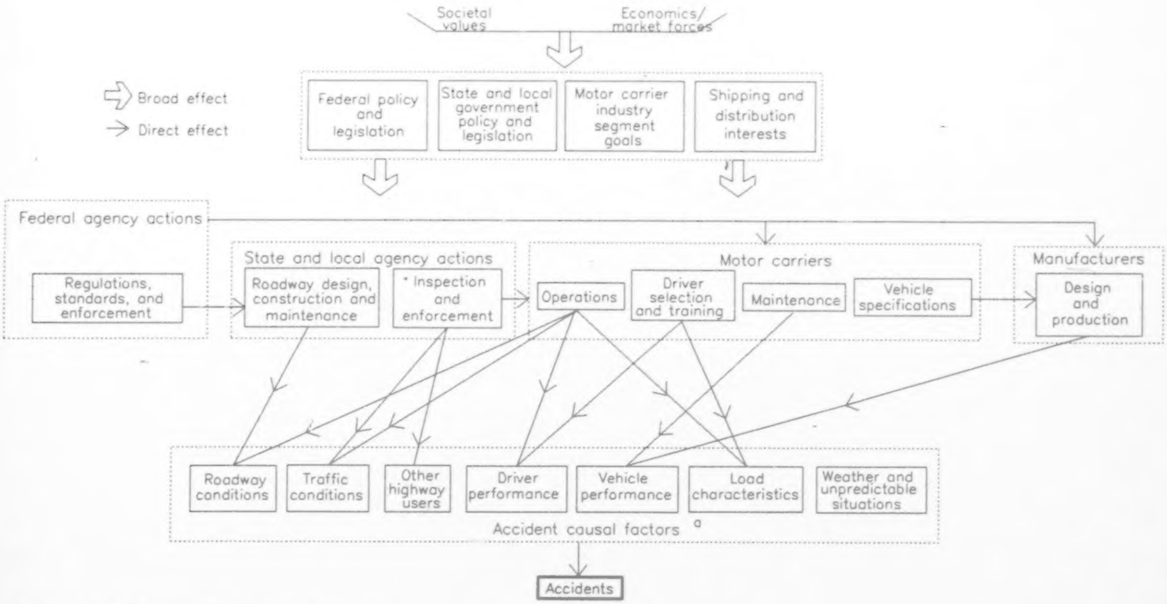
In those cases where exposure data are limited, OTA made inferences about the industry based solely on accident data rather than on both accident and exposure data. In each case, the sources of the information are made explicit. Improved data collection methods, such as those proposed in chapter 7, would facilitate more detailed and specific analyses.

Accident Causes

Accidents usually result from a chain of events, often initiated by a single occurrence, and complicated by a number of interacting factors (see figure 4-4). The potential for an accident is partially a function of the characteristics of the driver, including experience, training, age, attitude, physical condition (fatigue, intoxication, other debilitations), and psychological state. Other factors include the condition of the vehicle, highway design, and roadway characteristics; regulatory oversight, such as licensing and traffic enforcement; and the type of management supervision exercised by the carrier.

Still other factors contribute to the disproportionate number of fatalities associated with heavy truck accidents. Because of the size and weight of these trucks relative to cars, truck occupants have more

Figure 4-4.—Motor Carrier Accident Causal and Prevention Factors


Societal values
Economics/ market forces
Broad effect
Direct effect
Federal policy and legislation
State and local government policy and legislation
Motor carrier industry segment goals
Shipping and distribution interests
Federal agency actions
Regulations, standards, and enforcement
State and local agency actions
Roadway design, construction and maintenance
* Inspection and enforcement
Motor carriers
Operations
Driver selection and training
Maintenance
Vehicle specifications
Manufacturers
Design and production
Roadway conditions
Traffic conditions
Other highway users
Driver performance
Vehicle performance
Load characteristics
Weather and unpredictable situations
Accident causal factors a
Accidents

SOURCE: Office of Technology Assessment, 1988.

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[7] J. Fructus, "Highlights on Heavy Vehicle Safety in Europe," *Symposium on the Role of Heavy Freight Vehicles in Traffic Accidents* (Ottawa, Canada: Organisation for Economic Cooperation and Development, April 1987), vol. 1, p. 1-31.

protection in an accident than car occupants. The mismatch of size and mass between heavy trucks and cars and the special difficulties inherent in controlling a tractor-trailer on a highway designed for smaller vehicles are other major contributing factors to severe accident consequences. According to OTA's review of accident reports, the three factors most frequently associated with heavy vehicle accidents are: 1) speed too fast for conditions, 2) training of the driver, and 3) age of the vehicle.

Speed Too Fast for Conditions

The phrase "speed too fast for conditions" on accident report forms masks a variety of interlocking roadway and vehicle-related factors that affect driver performance in ways the driver may not understand and probably is unable to accommodate in any case. Vehicles operating at higher speeds operate closer to the limits of friction and rollover thresholds, and drivers have very little time to carry out emergency maneuvers at high speeds. (See chapter 5 for further discussion of the driver's role in this important area.) Often a posted speed is appropriate for cars and does not adequately consider the inherent incompatibility that exists in many instances between highway design and the large trucks now common. Certain interchange ramps on major highways are examples. Variations in speed among different vehicles increase the likelihood of an accident by providing more conflict situations, such as passing maneuvers and braking.[8]

Judging the speed suitable for road conditions is a complex task with a high potential for miscalculation, especially for drivers of heavy vehicles. A detailed investigation of the role of human factors in truck accidents in Finland points to failure in controlling the vehicle, in estimating the traffic situation, and in perception as the principal causes when human error is cited as the primary factor. Driver attitude and the physical or mental state of the driver emerge as key accident characteristics when human error is given as a secondary cause.[9]

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air Ave
lor Ave
MILE

Photo credit: Ohio State Police

Failure to slow down for curves in the road can have drastic consequences.

DRIVER PERFORMANCE

Speed figures prominently among driver-related factors in accidents. Where details are given on truck accident report forms (45 percent of the time in the National Accident Sampling System (NASS) from the years 1981-85), the most frequently cited include driving too fast for conditions, poor lane changes, and following too closely. (See figure 4-5.) An analysis of heavy truck at-fault collision reports in Oregon indicates that the principal causes cited are improper maneuvers, speed too fast for conditions, and driver fatigue and inattention.[10] Motor Carrier Safety Assistance Program (MCSAP) records show that several States have found excessive speed to be the most frequent human factor involved in accident causation. For example, Maryland, Massa-

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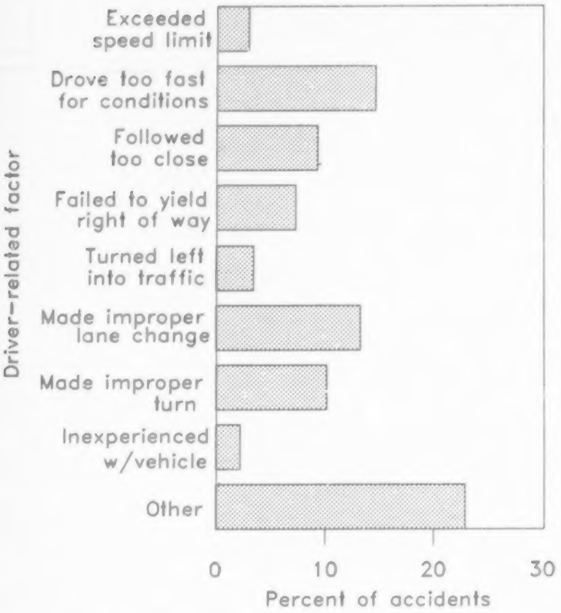
[8] D. Solomon, *Accidents on Main Rural Highways Related to Speed, Driver, and Vehicle* (Washington, DC: U.S. Department of Commerce, Bureau of Public Roads, July 1964).

[9] I.U. Stocker, "Statistical Analysis of HFV Accidents," *Symposium on the Role of Heavy Freight Vehicles in Traffic Accidents*, op. cit., footnote 7, vol. 1, p. 2-26.

[10] Oregon Public Utility Commissioner, *1984 Truck Inspections and Truck Accidents in Oregon* (Salem, OR: July 1985).

Figure 4-5.—Driver-Related Factors as Cited in Heavy Truck Accident Reports



SOURCE: Office of Technology Assessment, 1988; based on National Accident Sampling System data, 1981-85.

chusetts, Washington, and Oregon cite speeding as the most common accident causation factor.[11]

The frequencies of types of driver error for truck drivers in truck accidents in Washington State are shown in table 4-2. Areas of poor performance by the truck driver include inattention, exceeding reasonable speed, following too closely, and improper turning maneuvers.

Driver Training

Analysis of NASS data for the years 1981-85 indicates that training received by drivers of heavy vehicles involved in accidents is an important factor. Although data are limited, it appears that the majority of all heavy truck drivers have not received extensive or appropriate training.

Table 4-2.—Accident Causes Assigned in State of Washington Truck Crashes in 1984

Causal factor[a]	Number of times assigned	Percent of accidents
Driver errors:		
Inattention	1,128	22
Failure to yield right-of-way	513	10
Exceeding reasonable speed	670	13
Alcohol	56	1
Disregard stop sign/signal	58	1
Following too closely	277	5
Exceeding stated speed	55	1
Over center line	120	2
Improper passing	71	1
Improper turn	271	5
Apparently asleep	62	1
Drugs	1	—[b]
Failed to signal	22	—
Disregard warning sign/signal	25	—
Improper parking location	46	—
Improper signal	10	—
No lights/failed to dim	8	—
Deficient equipment	343	7
Other violations	606	12
No violation	1,674	33
Total accidents	5,051	

[a] The number of causal factors does not equal the number of total accidents because several causal factors are assigned in some accidents.

[b] Less than 1 percent.

SOURCE: Office of Technology Assessment, 1988, based on data from the Washington Utilities and Transportation Commission, and the National Highway Traffic Safety Administration

In an investigation of 35 accidents involving double trailers, the National Transportation Safety Board (NTSB) reported that the most common training given to drivers consisted of instructions on how to connect the combination units. No driver in the sample had received appropriate, specialized instruction on handling characteristics unique to twin-trailer operations.[12] OTA research indicates that training provided through schools and carriers varies tremendously in quality and duration. Some carriers prefer to hire drivers with over-the-road experience, rather than hiring inexperienced drivers regardless of training. For further discussion of this important issue, see chapter 6.

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[11] Motor Carrier Safety Assistance Program, *Annual Report* (Washington, DC: U.S. Department of Transportation, 1986).

[12] National Transportation Safety Board, unpublished remarks based on research for the *NTSB Heavy Truck Study*, presented at the National Motor Carrier Safety Workshop, Washington, DC, Mar. 11, 1987.

Previous Driving History

Heavy vehicle drivers involved in accidents often have received citations for previous safety violations, particularly for speeding and other moving violations, and have been involved in previous accidents. Over 40 percent of truck drivers involved in accidents had at least one prior speeding conviction in the previous 3 years. OTA's comparison of NASS (1981-85) and the Federal Accident Reporting System (FARS) (1983) data revealed little difference in the previous violation and accident records of truck drivers involved in nonfatal and fatal accidents.

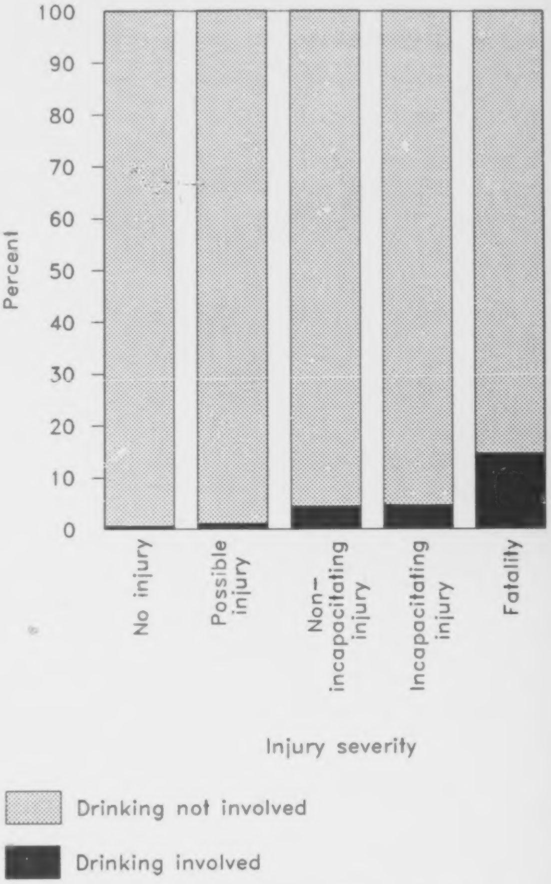
Drugs and Alcohol

Truck accident reports often show a low percentage of convictions for driving while intoxicated among truck drivers. Because of the importance of good driver performance for safety and the lack of data on drugs as contributors to accidents, NTSB is conducting a study of fatal truck accidents to determine the extent of driver impairment by alcohol and drugs. The study is expected to be completed in 1989.

Heavy vehicle drivers themselves perceive driver drug and alcohol abuse to be relatively frequent. In a 1986 survey sponsored by the Regular Common Carrier Conference of 1,319 long-haul, tractor-trailer truck drivers in Florida,[13] drivers were asked their perception of drug and alcohol use. The average respondent estimated that 36 percent of fellow drivers sometimes drive under the influence of drugs, and 18 percent of drivers sometimes drive under the influence of alcohol.

OTA analysis of NASS data indicated that alcohol involvement and accident severity are strongly related. Figure 4-6 shows the severity of injuries as a function of drinking by heavy vehicle drivers. The relationship between drinking and accident severity suggests that alcohol alone is a major factor in fatal accidents.

Figure 4-6.—Injury Severity in Heavy Truck Accidents Relative to Truck Driver Drinking



SOURCE: Office of Technology Assessment, 1988; based on National Accident Sampling System data, 1981-85.

Age and Experience

Young and inexperienced truck drivers exhibit the highest risk of accidents,[14] with those under 25 years of age six times more likely than other heavy truck drivers to be involved in an accident.[15] Drivers with less than 1 year of experience constitute 1 percent of the carrier work force, yet account for 3 percent of the accidents.[16]

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[13] R. Beilock, *1986 Motor Carrier Safety Survey* (Alexandria, VA: Regular Common Carrier Conference, 1987).

[14] I.J. Jones and H.S. Stein, *Effects of Driver Hours of Service on Tractor-Trailer Crash Involvement* (Washington, DC: Insurance Institute for Highway Safety, September 1987) p. 11; M.J. Sanders, Canyon Research Group, Inc., "A Nationwide Survey of Truck and Bus Drivers," unpublished manuscript, March 1977; and P. Green et al., University of Michigan, "Accidents and the Nighttime Conspicuity of Trucks," unpublished manuscript, January 1980.

Fatigue

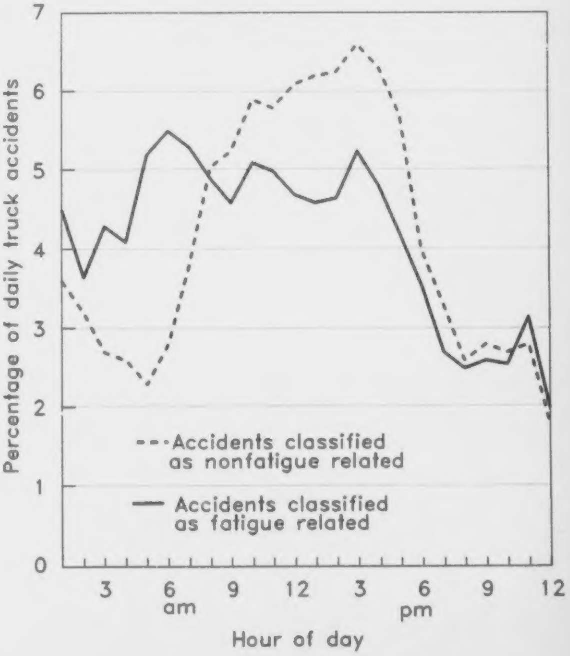
Fatigue reduces a driver's sensorial and motor capacities. Research has shown that truck drivers are susceptible to both sudden fatigue, due to temporary irregularities of the sleep cycle, and accumulated fatigue, due to long working hours.

Significant increases in driver errors and decreases in alertness have been noted as early as the fourth hour of shift driving time and generally increase throughout the trip, except for a slight recovery near the end of a trip.[17] The lowest levels of alertness occur for most drivers between 2:00 a.m. and 7:00 a.m. Moreover, the adverse effects of prolonged driving are probably more pronounced for drivers aged 45 or older than for young drivers.[18] Drivers on irregular schedules experience more fatigue than drivers on regular schedules, and the effects occur earlier.[19] A recent study using a case-control design to establish comparable samples for 300 truck crashes indicated that the relative risk of crash involvement for truck drivers driving more than 8 hours is almost twice that for drivers driving fewer hours.[20] Moreover, drivers using a sleeper cab for rest periods experience greater fatigue than relay drivers.[21]

Accident data involving interstate commercial motor vehicle drivers show fatigue-classified accidents as proportionally higher during the hours between 11:00 p.m. and 8:00 a.m., suggesting an impact due to circadian rhythm (see figure 4-7).[22] NTSB also notes fatigue or hours-of-service violation as a factor in over 30 percent of its accident investigations.[23] Long hours of driver duty time, some as long as 26-31 consecutive hours prior to accidents, have been documented, often a result of carrier dispatch, delivery, or other requirements. Road and vehicle visibility are major contributing factors to accidents when a driver is fatigued, as is speed too fast for conditions.

A study of truck drivers in France found that fatigue is a major problem for drivers on the road for several days in a row. These drivers worked as fre-

Figure 4-7.—Relationship of Driver Fatigue to Accidents, by Hour of Day



SOURCE: Office of Technology Assessment, adapted from K.D. Hackman et al. (eds.), *Analysis of Accident Data and Hours of Service of Interstate Commercial Motor Vehicle Drivers* (Washington, DC: U.S. Department of Transportation, Federal Highway Administration, August 1978).

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[15] K.D. Hackman et al. (eds.), *Analysis of Accident Data and Hours of Service of Interstate Commercial Motor Vehicle Drivers* (Washington, DC: U.S. Department of Transportation, Federal Highway Administration, August 1978).

[16] Jovanis, op. cit., footnote 5.

[17] William Harris et al., Human Factors Research, Inc., *A Study of the Relationships Among Fatigue, Hours of Service, and Safety of Operations of Truck and Bus Drivers* (Washington, DC: U.S. Department of Transportation, Federal Highway Administration, Bureau of Motor Carrier Safety, November 1972).

[18] Ibid.

[19] Robert T. Mackie and James C. Miller, Human Factors Research, Inc., *Effects of Hours of Service, Regularity of Schedules and Cargo Loading on Truck and Bus Driver Fatigue* (Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, October 1978).

[20] Jones and Stein, op. cit., footnote 14.

[21] Mackie and Miller, op. cit., footnote 19; and Robin P. Hertz, "Sleeper Berth Use as a Risk Factor for Tractor-Trailer Driver Fatality," presented to American Association for Automotive Medicine, New Orleans, LA, September 1987.

[22] Hackman et al., op. cit., footnote 15.

[23] National Transportation Safety Board, op. cit., footnote 12, p. 2.

quently as other drivers during the day, yet remained on duty, driving and performing other tasks after normal business hours. This pattern led to both sudden fatigue and accumulated fatigue.[24] The study used a survey of truck driving patterns to measure exposure; periods of high accident risk were determined by comparing accidents with exposure. Data indicate that accident involvement rates generally increase throughout the day, reaching peaks at mealtimes, at the end of the afternoon, into the evening, and late at night. A risk peak in the first hour of any shift has been reported by other heavy truck safety research.[25]

VEHICLE FACTORS

Vehicle design and performance affect truck safety, just as maintenance and operating practices do. Design and performance issues involve brake system capabilities, handling and stability, vehicle crashworthiness, and truck occupant protection. Maintenance practices include preventive maintenance as well as replacement of inoperable or worn parts. Vehicle operating practices include cargo loading, cargo tiedown, overall weight, and weight distribution.

The role of vehicle factors in an accident may be more subtle than that of the driver. While vehicle factors may not precipitate a crash, they can reduce the vehicle's performance capabilities below the threshold where safety can be maintained when traffic or roadway conditions require an emergency maneuver. These factors thus play a significant role in highway environments, such as heavy traffic, steep grades, curves, or narrow roadways, where peak vehicle performance is needed.

The subtleties of the role of the vehicle in accidents are emphasized in Oregon accident records for heavy trucks. Vehicle defects were cited as the accident cause in only 6.7 percent of all cases.[26] However, when truck at-fault accidents were disaggregated, over 20 percent were linked to mechanical defects, highlighting the potential for vehicle factors in preventing accidents as well as for mitigating severity.

Problems associated with vehicle equipment show up in MCSAP inspection reports. Although the number of out-of-service citations resulting from vehicle inspections varies among States, a significant number of trucks (ranging from 30 to 60 percent) are placed out of service for equipment violations immediately.[27]

Braking Systems

Defective brakes were the most common equipment violation cited in the MCSAP reports, followed by poor lighting and tire condition. Brake system failures were the single largest group of causes cited for large truck accidents associated with mechanical defects, constituting 31 percent of the total.[28]

The nature of brake problems has been documented in greater detail by the Oregon Public Utility Commission,[29] which found that over 60 percent of all violations related to brakes being out of adjustment; another 14 percent related to problems with the brake lining. Therefore, roughly three of every four brake-related citations identified problems that normal brake maintenance could easily detect and correct. NTSB's investigations reveal that in many cases the truck driver had responsibility for proper brake adjustment, but the carrier had not required or furnished appropriate training.[30]

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[24] Patrick Hamelin, "Truck Driver's Involvement in Traffic Accidents as Related to Their Shiftworks and Professional Features," *Symposium on the Role of Heavy Freight Vehicles in Traffic Accidents*, op. cit., footnote 7, vol. 2, p. 3-107.

[25] Jovanis, op. cit., footnote 5, p. 8.

[26] Oregon Public Utility Commissioner, op. cit., footnote 10.

[27] The process of selecting vehicles for inspection varies among States. Out-of-service citations are likely to be high (greater than 50 percent) when the selection process is nonrandom, based on inspecting vehicles that outwardly appear to have problems. Random selection yields out-of-service citation rates closer to 30 percent. Paul Melander, Tennessee Public Service Commission, personal communication, Mar. 23, 1988.

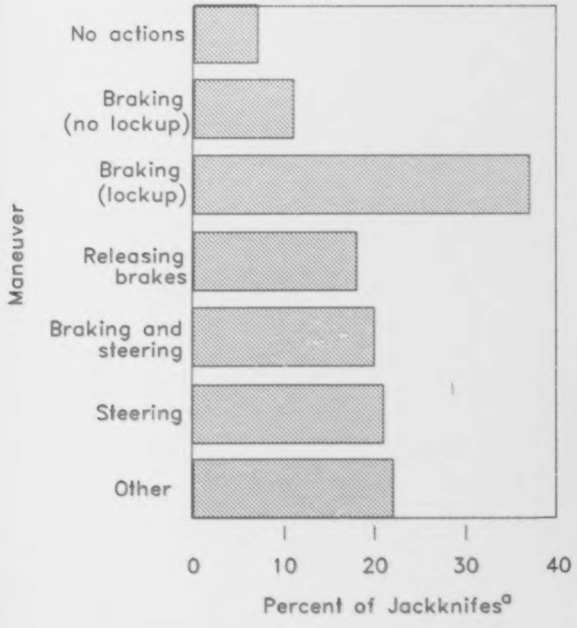
[28] Bureau of Motor Carrier Safety, *1976-1978 Analysis of Motor Carrier Accidents Involving Vehicle Defects of Mechanical Failure* (Washington, DC: U.S. Department of Transportation, November 1979).

[29] Oregon Public Utility Commissioner, op. cit., footnote 10.

[30] National Transportation Safety Board, op. cit., footnote 12, p. 3.

Poor brake adjustment and maintenance coupled with sudden braking or other avoidance maneuvers can increase the possibility of jackknifing,[31] a significant problem as shown in figure 4-8. Jackknifing potential is exacerbated by wet road conditions[32] and is especially prevalent among lightly loaded or empty vehicles.[33] A comparison of accident-involved articulated vehicles from the NASS (1981-85) and FARS (1983) databases does not, however, show jackknifing to be overrepresented in fatal accidents.

Figure 4-8.—Jackknifes Related to Attempted Accident Avoidance Maneuvers



^a These numbers do not add to 100 since some jackknifes are attributed to multiple maneuvers.

SOURCE: Office of Technology Assessment, 1988; based on National Accident Sampling System data, 1981-85.

Tires

Data from Oregon indicate that in 1984, 9.9 percent of truck at-fault collisions were attributed to mechanical causes, although for single-vehicle truck crashes 21 percent were attributed to mechanical causes and 24 percent of these to tires. Other data indicate tires to be the second leading cause of crashes in which mechanical defects were primary contributing factors.[34]

Tires have not been examined as extensively as other factors as a cause of accidents. Tire specialists indicate that a single tire blowout—even on the steering axle—should not result in total loss of control by the driver, unless other circumstances or equipment problems exist. Looseness in the steering system, striking a curb, or panic braking may, in combination with a blowout, cause the driver to lose control. Because specifying an accident cause is complicated, and the tire blowout is easily remembered and identified,[35] it is difficult to determine whether a blowout preceded a crash or occurred as a result of it.

Rollovers and Vehicle Handling and Stability

Rollovers often occur on curved roads, and vehicle factors include handling characteristics and sta-

Photo credit: Michael Hines, OTA staff

Vehicle handling skills are challenged when drivers transport especially wide loads.

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[31] Jackknifing is also discussed in ch. 5.

[32] H.S. Stein and I.J. Jones, *Crash Involvement of Large Trucks by Configuration: A Case Control Study* (Washington, DC: Insurance Institute for Highway Safety, January 1987).

[33] C. Winkler et al., *Parametric Analysis of Heavy Duty Truck Dynamic Stability*, Report No. DOT-HS-806-411 (Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, March 1983).

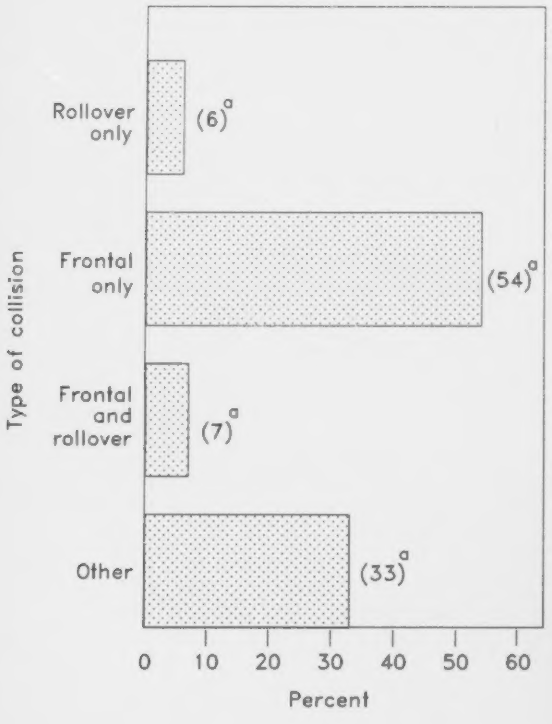
[34] Insurance Institute for Highway Safety, *Big Trucks* (Washington, DC: 1985).

[35] Christopher G. Shapeley, "A Comparison of Car and Truck Safety," presented at the American Society of Civil Engineers Symposium on Accommodation of Trucks on the Highway: Safety in Design, Nashville, TN, May 11, 1988.

bility as well as load shifting, deficient brakes, and deficient tires. (For information on roadway contributory factors see chapter 5.) Driver-related factors include inattention, falling asleep, loss-of-control/skidding, speeding, and avoidance maneuvers. Operational factors, such as unbalanced cargo loads and trailer loads with high centers of gravity, also affect vehicle stability.

Poor handling and vehicle instability often lead to vehicle rollovers, which, in turn, strongly correlate with accident severity. Rollovers are more likely to be associated with accidents involving a driver fatality relative to all heavy truck accidents (see figure 4-9). OTA's NASS (1981-85) and FARS (1983) analyses also show that rollovers occur in 7.6 percent of all heavy truck accidents, but are a characteristic of 16.5 percent of truck accidents involving a fatality. Other studies substantiate the relationship between rollover and fatal accidents[36] and show that the risk of injury is higher in rollover accidents involving a single vehicle relative to multiple-vehicle accidents.[37]

Figure 4-9.—Tractors Involved in Fatal Accidents, by Type of Collision



a Percentage of all tractor accidents.

SOURCE: Office of Technology Assessment, 1988; based on Motor Vehicle Manufacturers Association data, 1987.

Rollovers are a particularly acute problem for double-trailer combinations. Although the sample of doubles accidents in the NASS database is quite small, the incidence of rollovers in doubles accidents is very high. Studies show that doubles are three to four times more likely to overturn than singles in noncollision accidents[38] and that rollover occurred in close to 70 percent of twin-trailer accidents. The most common occurrence was rollover of the rear trailer.[39]

Override/Underride

When accidents occur between large trucks and cars, the mismatch between truck and car bumper heights causes trucks to override smaller vehicles or smaller vehicles to underride trucks. Override/underride accidents occur more frequently at night, when darkness reduces visibility for all drivers. Figure 4-10 shows that the override/underride prob-

Photo credit: Land Line

Flatbed trailers are particularly difficult to see, creating the potential for severe underride accidents.

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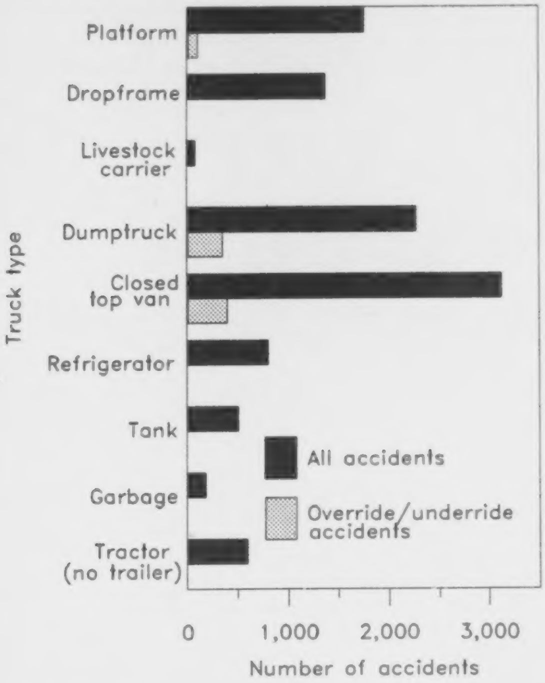
[36] National Highway Traffic Safety Administration, *Truck Occupant Protection*, prepared in response to the Motor Carrier Safety Act of 1984 (Washington, DC: December 1986).

[37] Stein and Jones, op. cit., footnote 32, p. 13.

[38] Oliver Carsten, "U.S. Accident Experience of Single and Double Trailer Combinations," *Symposium on the Role of Heavy Freight Vehicles in Traffic Accidents*, op. cit., footnote 7, vol. 1, p. 2-80, table 5.

[39] National Transportation Safety Board, op. cit., footnote 12, p. 1.

Figure 4-10.—Accidents and Override/Underride in Reduced Lighting Conditions, by Truck Type



SOURCE: Office of Technology Assessment, 1988; based on National Accident Sampling System data, 1981-85.

lem is greater for dump trucks, closed-top vans, or flatbed or platform trailers; platform trailers present the most problems.[40]

A comparison between fatal and nonfatal car-into-truck accidents shows that fatalities occur more frequently in underride accidents, including many from contact with the side of the truck. Trucks and trailers with devices to prevent underride were more likely to be involved in nonfatal accidents,[41] highlighting the value of such protection.

Truck Configuration and Utilization

Accident rates and types vary for straight and combination trucks, for single- and double-trailer operations, and for loaded and empty trucks. The operating characteristics and contributing factors—the number of powered axles, cab configuration, type of trailer, type of cargo, trip length, time of day, road type, and driver age and experience—differ for every accident. Each factor needs to be considered independently and interactively in any comprehensive analysis.[42] In fact, for single-trailer operation alone, involvement rates differed significantly by trailer type and location, as shown in table 4-3.

Table 4-4 shows fatal accident involvement percentages (truck driver and other vehicle driver) by truck body type for combination trucks. These data underscore the overinvolvement of tank trucks and the relative severity of dump truck collisions for the other vehicle driver.

The relative safety of single- and double-trailer combination trucks is highly controversial, and several studies have examined their relative risks. Each study differs in methodology and sources of data, making a comprehensive and coherent assessment difficult. For example, studies of truck accidents on turnpikes permit consistent accident and exposure information because the intercity operations of doubles are adequately represented. However, the restriction to turnpike operation eliminates consideration of the entire trip from origin to destination. National studies do not allow control for geographic location and roadway type. Thus, study results have varied due primarily to: 1) differences in exposure survey methods and uncertainties in the resulting estimates of exposure, 2) unreliable and missing ac-

Table 4-3.—Single-Trailer Involvement Rate (per 100 million vehicle-miles)

Trailer type	Local	Intercity
Van	168.0	75.9
Flatbed	69.9	106.8
Tank	142.2	78.1
Auto	241.6	73.6
Dump	46.1	33.1

SOURCE: T. Chirachavala and J. O'Day, *A Comparison of Accident Characteristics and Rates for Combination Vehicles With One or Two Trailers*, Report No. UM-HSRI-81-41 (Ann Arbor: University of Michigan, August 1981).

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[40] Motor Vehicle Manufacturer's Association, *Proceedings of the National Truck Safety Symposium* (Washington, DC: June 1987), pp. 85-86; Motor Vehicle Manufacturers Association, *Motor Truck Research* (Washington, DC: November 1985).

[41] Motor Vehicle Manufacturers Association, *Motor Truck Research*, op. cit., footnote 40, pp. 7, 9.

[42] T. Chirachavala and J. O'Day, *A Comparison of Accident Characteristics and Rates for Combination Vehicles With One or Two Trailers*, Report No. UM-HSRI-81-41 (Ann Arbor, MI: University of Michigan, August 1981).

Table 4-4.—Distribution of Combination-Unit Truck Mileage and Fatal Accident Involvements by Body Type, in Texas

Body type	Percent of miles traveled	Percent of combination-unit truck driver fatalities	Percent of "other vehicle" driver fatalities occurring in collisions with combination-unit trucks
Van	45.5	28.1	24.5
Platform	22.2	25.2	27.8
Tank[a]	15.0	33.0	20.8
Dump	7.3	3.0	11.1
Pole/log	1.2	0.7	1.9
Livestock	1.3	6.7	8.0
All others	7.2	3.3	5.9
Total	100.0[b]	100.0	100.0

[a] Includes dry bulk, liquid, and gas.

[b] Sum does not equal 100 percent due to rounding.

SOURCES: Truck Inventory and Use Survey/Texas 1982 and Texas State Accident Data (1981-1983); National Highway Traffic Safety Administration.

cident data, 3) differences in the definition of an accident and/or large truck, 4) differences in vehicle classification survey methods, 5) differences in driving environment, and 6) inherent stochastic variation associated with small samples.[43] Despite these variations, a summary of study results to date follows.

Using accident and exposure data during 1966-70 on the Indiana Toll Road, one study concluded that doubles had a significantly lower involvement rate than did singles.[44] However, doubles had more injuries or fatalities per accident than singles. No effort was made to separate these data by rural or urban location.

In 1977, an FHWA study analyzed the accident experience of seven large motor carriers for a 7-year period and found no significant differences between accident and severity rates of singles and doubles.[45] The carriers surveyed were among the largest common and private carriers in the country; no attempt was made to control for different operating environments.

A followup study conducted by FHWA in 1978, using data from California, found that the only significant difference in doubles and singles involvement rates on a vehicle-mile basis, was a higher fatality rate for doubles.[46] However, when a cargo-based exposure measure (ton-miles) is used, the higher tonnage capability of doubles results in a higher accident rate and injury rate for singles. Although there were problems with the accuracy of the exposure estimates in this study, the findings illustrate some of the differences in the way this topic is viewed.

The Insurance Institute for Highway Safety used a case-control study design to account for differences in operating characteristics between singles and doubles.[47] The study concluded that doubles are two to three times more likely to be involved in accidents than other large trucks on the same type of roadway. This approach preselected locations where accidents have already occurred, perhaps for reasons unrelated to vehicle configuration. The study's findings have generated substantial controversy.

Other controlled studies have been conducted for a less-than-truckload carrier by Northwestern University.[48] Using over 160 traffic links connecting terminal pairs served by both singles and doubles in 1983 and 1984, the studies found no statistically conclusive evidence of differences between the accident rates of singles and doubles. A similar study conducted for OTA corroborated these findings; moreover, after an initial driver learning period, the doubles safety record improved sufficiently to exceed that of the singles.[49]

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[43] G.A. Sparks and J. Bielka, "Large Truck Accident Experience in Western Canada: A Case Study of Two Large Fleets," *Symposium on the Role of Heavy Freight Vehicles in Traffic Accidents*, op. cit., footnote 7.

[44] R.E. Scott and J. O'Day, *Statistical Analysis of Truck Accident Involvement*, Final Report (Ann Arbor, MI: Highway Safety Research Institute, December 1971).

[45] Federal Highway Administration, *Safety Comparison of Doubles Versus Tractor Semi-Trailer Operation* (Washington, DC: U.S. Department of Transportation, 1977).

[46] H. McGee et al., *Comparison of California Accident Rates for Single and Double Tractor-Trailer Combination Trucks*, Report No. FHWA-RD-78-94 (Washington, DC: U.S. Department of Transportation, Federal Highway Administration, March 1978).

[47] Stein and Jones, op. cit., footnote 32.

[48] Jovanis, op. cit., footnote 5.

An extensive Transportation Research Board study of the relative safety of single- versus double-trailer trucks concluded that doubles have slightly more accident involvements per mile traveled than singles operated under identical conditions at highway speeds.[50] This and other studies indicate that considerable differences exist in single- and double-trailer accident involvement rates by road type, emphasizing the importance of the operating environment as well as the configuration of the truck.[51]

Accident rates for articulated trucks exceed those for straight trucks by factors of three to four, depending on location and road conditions.[52] The consequences of articulated truck accidents are more serious as well. While single-unit trucks have nonfatal accident rates comparable to nonfatal accident rates for combination trucks (see table 4-5), their rate of involvement in fatal accidents is considerably lower.[53]

Whether the tractor is operating as a bobtail (not pulling a trailer) or attached to a semitrailer also affects accident rates. Bobtails are 14 times more likely to be involved in a fatal accident, and their injury involvement rate is 19 times greater than for the tractor-semitrailer configuration.[54] In addition, empty tractor-semitrailer trucks are more likely to be involved in crashes than fully loaded trucks.[55] This is probably due to the difficulty in maintaining control when braking empty or partially loaded tractor-trailers. (See chapter 5, figure 5-3.)

Table 4-5.—Vehicle Involvement Rates in Fatal and Nonfatal Accidents in 1984

	Combination-unit trucks	Single-unit trucks
Vehicles in fatal accidents ...	4,232	956
Vehicle involvements in fatal accidents (per 100 million vehicle-miles)	5.5	1.8
Vehicle involvements in nonfatal accidents (per 100 million vehicle-miles)	279.0	299.0

SOURCES: National Highway Traffic Safety Administration, Fatal Accident Reporting System, National Accident Sampling Systems, Federal Highway Administration, Highway Statistics, Truck Inventory and Use Survey.

Truck Occupant Protection

Less than 1 percent of all medium and heavy truck occupants involved in accidents are killed, and only 10 percent are injured.[56] Nevertheless, truck driving is considered a relatively dangerous occupation. Table 4-6 shows fatality rates for selected occupations, indicating that truck driving and mining are the most dangerous industrial occupations.

A truck driver wearing a seat belt is much less likely to be injured or suffer severe injury in an accident, primarily because he is less likely to be thrown out of the cab by the impact. The majority of truck drivers (76 percent) involved in accidents were not wearing seat belts, as shown in figure 4-11.[57] FARS (1984) data indicate that total or partial ejection was involved in 38 percent of combination-unit truck occupant fatalities. Truck occupants were also ejected after an accident more frequently than were passenger car occupants (25 percent).[58]

Entrapment, cab crush, and contact with interior surfaces have serious consequences for truck occupants who remain in the cab during an accident. A study of truck occupants in rural accidents identified ejection and steering-assembly contact as the leading sources of injury, followed by contact with

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[49] P.P. Jovanis and I. Zabaneh, "Analysis of Carrier-Based Safety Data," OTA contractor report, February 1988.

[50] Transportation Research Board, *Twin Trailer Trucks*, TRB Special Report 211 (Washington, DC: National Research Council, 1986).

[51] Carsten, op. cit., footnote 38.

[52] Stein and Jones, op. cit., footnote 32, p. 9.

[53] National Highway Traffic Safety Administration, op. cit., footnote 36.

[54] K. Campbell and O. Carsten, *Fleet Accident Evaluation of FMVSS 121*, Report No. DT-HS-806-261 (Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, August 1981).

[55] Stein and Jones, op. cit., footnote 32, p. 11.

[56] National Highway Traffic Safety Administration, op. cit., footnote 36.

[57] This contrasts somewhat with the safety belt use rate for truck drivers not involved in accidents. A nonobtrusive survey of safety belt use among combination-unit truck drivers revealed that over 93 percent were not using their belts. P. Allison and R. Tarkir, "Heavy Truck Occupant Restraint Use," prepared for the National Highway Traffic Safety Administration, September 1982.

[58] National Highway Traffic Safety Administration, op. cit., footnote 36, p. 14.

Table 4-6.—Occupational Fatalities in 1984 .

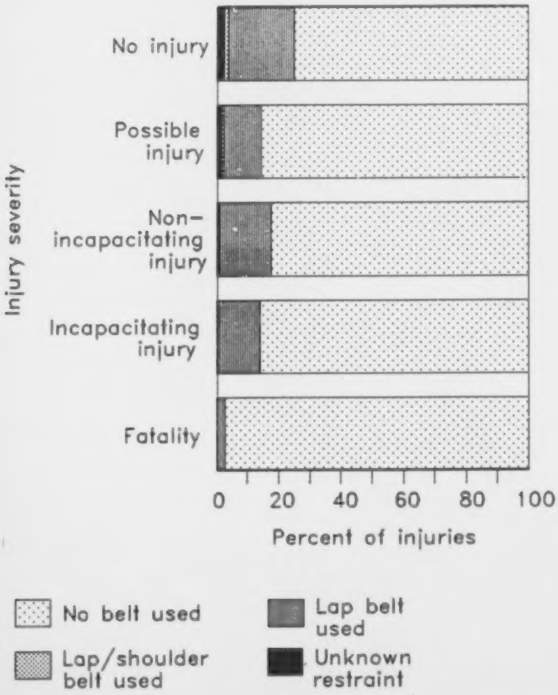
Industry group	Workers ($\times 10^3$)	Deaths[a]	Deaths/10^5 workers
All industries	104,300	11,500	11
Trade	24,000	1,200	5
Manufacturing	19,900	1,100	6
Service	28,900	1,900	4
Government	15,900	1,400	9
Transportation and public utilities	5,500	1,500	27
Construction	5,700	2,200	39
Agriculture	3,400	1,600	46
Truck drivers	**1,876[b]**	**1,087[c]**	**58**
Mining, quarrying	1,000	600	60

[a] National Safety Council, *Accident Facts 1985*.
[b] U.S. Department of Labor, *Employment and Earnings, January 1985*.
[c] Federal Accident Reporting System, 1984.

SOURCE: National Highway Traffic Safety Administration.

the windshield and the door area.[59] A study of injury patterns of fatally injured truck drivers concluded that severe abdominal injuries in combination with head and/or chest injuries were more likely among combination-unit truck drivers than among drivers of other truck types.[60] The nature of these injuries suggests the steering wheel is particularly dangerous. The steering wheel was also identified as the most prominent source of injury in an analysis of 124 accidents involving Volvo trucks in Sweden.[61]

Figure 4-11.—Truck Driver Seat Belt Use, by Injury Severity



SOURCE: Office of Technology Assessment, 1988; based on National Accident Sampling System data, 1981-85.

Some information is available on the relative safety of cab-over-engine units (COE) and conventional cabs. For example, the risk of injury to a COE driver is 15 percent higher, and the risk of injury to the nontruck driver slightly lower, when a COE is involved.[62] FARS data show that COEs have a greater involvement in accidents in which a fatality occurs as well as in accidents involving a truck-driver fatality.

The initial stimulus for the COE design was Federal length restrictions that are no longer in effect. Many drivers claim COEs have poorer ride quality and increased vibration that cause discomfort and fatigue.

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[59] H. Robinson et al., *Trucks in Rural Injury Accidents*, NHTSA Report No. HS-800-232 (Washington, DC: U.S. Department of Transportation, July 1969.

[60] T. Karlson et al., "Fatally Injured Truck Drivers," *Proceedings of the 21st Conference of the American Association of Automotive Medicine* (Arlington Heights, IL: American Association of Automotive Medicine, September 1977).

[61] A. Anderson et al. "Injuries in Trucks and the Effectiveness of Seat Belts," *Proceedings of the 24th Conference of the American Association of Automotive Medicine* (Arlington Heights, IL: American Association of Automotive Medicine, October 1980).

[62] Motor Vehicle Manufacturers Association, op. cit., footnote 41, p. 11.

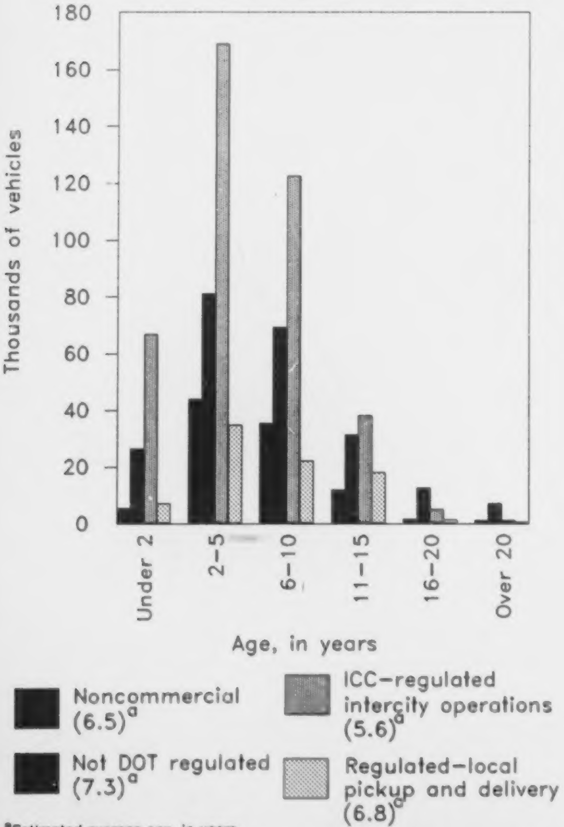
SAFETY OF NONREGULATED CARRIERS

A substantial safety concern has been the lack of Federal regulatory oversight of carriers operating exclusively in commercial zones and in other federally exempt categories. Analysis of NASS (1981-85) data indicates that nearly two out of every five accidents involve a heavy truck belonging to a carrier that is not Interstate Commerce Commission (ICC)-regulated. Oregon officials report that in 1984 the highest at-fault accident rate belonged to ICC-exempt, interstate carriers.[63]

Figure 4-12 shows the age distribution of heavy trucks involved in accidents. Differences in the quality of various truck operations are also apparent when examining Federal roadside inspection data. Table 4-7 shows that ICC-exempt carriers have somewhat higher violation rates than other carriers and slightly more serious safety problems. Systematic interpretation is impossible because of numerous changes in recent years in coverage by ICC regulations and in the application of Federal safety regulations to previously exempt carriers.

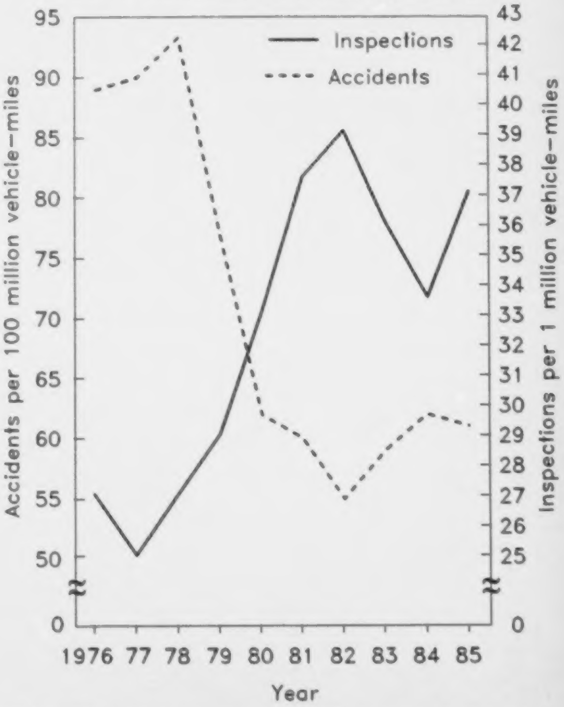
Roadside inspections can serve as effective accident prevention measures. A 10-year California State study found a clear inverse relationship between the number of roadside inspections and the number of truck at-fault accidents.[64] (See figure 4-13.) Although other factors undoubtedly influenced operations over the study period, the apparent correlation between increased enforcement activities and on-the-road safety improvement is hard to ignore.

Figure 4-12.—Vehicle Age by Regulatory Status



aEstimated average age, in years.
KEY: DOT = Department of Transportation; ICC = Interstate Commerce Commission.
SOURCE: Office of Technology Assessment, 1988; based on National Accident Sampling System data, 1981-85.

Figure 4-13.—Truck Inspection and Truck Accident Rates for California State Highways, 1976-85



SOURCE: Office of Technology Assessment, 1988; adapted from California Highway Patrol/State of California Public Utilities Commission, *Joint Legislative Report on Truck Safety* (San Francisco, CA: November 1987), p. 37

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[63] Oregon Public Utility Commissioner, op. cit., footnote 10, p. 39.

[64] California Highway Patrol, *Critical Item Inspection Fact Sheet* (Sacramento, CA: 1986).

Table 4-7.—BMCS Roadside Inspection of All Carriers (in percent)

	ICC-authorized	Private	ICC-exempt other
1983			
Without violations	36	25	28
With violations	64	75	72
Out-of-service violations	28	25	32
1984			
Without violations	29	21	20
With violations	71	79	80
Out-of-service violations	31	29	36

KEY: BMCS = Bureau of Motor Carrier Safety.
ICC = Interstate Commerce Commission

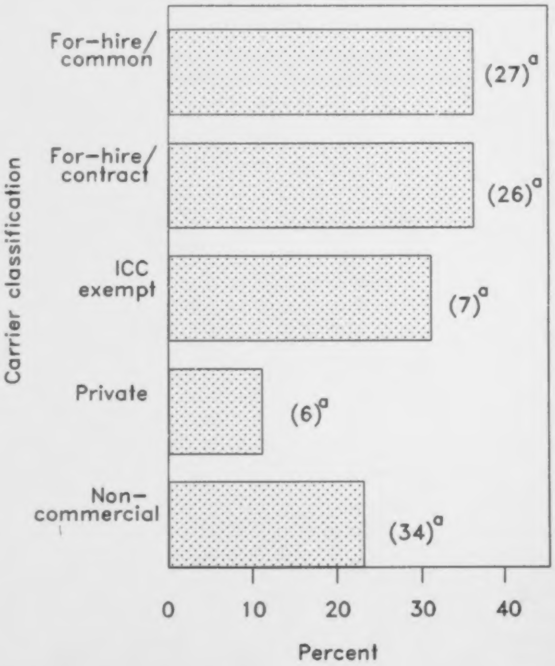
SOURCE: Bureau of Motor Carrier Safety, *BMCS Annual Roadside Inspection 1983 and 1984* (Washington, DC: September 1985).

ECONOMIC FACTORS

The U.S. trucking industry represents a diverse mix of carriers, drivers, and truck owners operating with a broad range of safety practices and levels of management control. Some limited evidence links the amount of motor carrier investment in safety-related activities to the firm's overall financial condition. One examination of for-hire, general freight carriers found that the average carrier that eventually goes bankrupt spends less on safety and maintenance, has older equipment, and depends more on owner-operators.[65] However, the basis for this finding was not a comparison of accident rates to carrier profitability, but rather a comparison of expenditures related to safety performance to a weighted combination of financial ratios. Moreover, studies of this kind are hampered by the scarcity of industry financial data maintained by ICC, particularly for new entrants. Furthermore, ICC is eliminating requirements for detailed financial reports from those carriers who must still submit records.

The question of whether driver speeding is related to the method of compensation extended to drivers has been hotly debated. Undeniably, drivers paid by the job have an economic incentive to speed to produce more revenue-generating trips within a given time period. However, numerous other factors affect a driver's desire to speed. Figure 4-14 shows the relationship between carrier classification and speeding violations among truck drivers involved in accidents. Although speeding is prevalent across all segments of the carrier industry, excessive speeding is more frequently found among ICC-exempt and for-hire carriers according to accident data. Leased drivers have the highest incidence of previous speeding violations and previous license suspensions and revocations. Furthermore, the

Figure 4-14.—Percentage of Trucks That Speed, by Carrier Classification



ᵃMarket share in percent.
KEY: ICC = Interstate Commerce Commission.
SOURCE: Office of Technology Assessment, 1988; based on National Accident Sampling System data, 1981-85.

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[65] G. Chow, "Deregulation, Financial Condition and Safety in the General Freight Trucking Industry," presented at the Northwestern University Conference on Economic Deregulation and Safety, Evanston, IL, June 1987.

NASS (1981-85) data show that leased drivers and drivers operating for ICC-exempt carriers are disproportionately involved in drunk driving accidents. The validity of these figures is difficult to establish because of the relatively small sample size and because NASS data do not have well-defined driver or carrier classification categories.[66] Furthermore, it is difficult to delineate the class of driver on a specific trip because the same driver could be leased or not leased in different driver classifications and may drive in many different types of operations during the year.

ENFORCEMENT

State terminal audits conducted as part of the MCSAP program raise important carrier management safety issues. In Arizona, for instance, the three most common carrier violations are: 1) failure to maintain driver qualification files, 2) hours-of-service violations, and 3) failure to maintain inspection, repair, and maintenance records. Officials familiar with Oregon's audit results concluded that carriers do not comply with the requirements because of a lack of knowledge or understanding of the regulations as applied to their operations. Moreover, even when the regulations are understood, the cost of noncompliance is so low that it is not an effective deterrent. These findings point to the need for a better education and enforcement program.

In Michigan, a direct link has been established between driver qualifications, hours of service, and vehicle operations and commercial vehicle accidents. Making compliance with driver qualification procedures a direct responsibility of carriers has proven to be an effective accident prevention tool.[67]

ROADWAY ENVIRONMENT

Roadway environment factors are often listed incidentally on many accident reports. Road design/geometry, weather, lighting conditions, traffic conflict opportunity, and operating speeds can all create conditions that are unforgiving of errors, making an accident more likely.

Road Type

The functional class of the roadway has a profound impact on heavy truck involvement rates for both fatal and nonfatal accidents[68] (see table 4-8). A similar relationship between rural/urban and Interstate/other roadway fatality rates appears in a corroborating study, although the magnitudes differ somewhat.[69]

Figure 4-15 depicts frequencies of heavy truck accidents and fatal heavy truck accidents by road classification. Of particular significance is the proportion of heavy truck, fatal accidents (relative to all large truck accidents) that occur on U.S. and State highways, particularly rural, non-Interstates. Some characteristics of these roads create the potential for severe accidents.

Table 4-8.—Single-Trailer Accident Involvement Rates by Highway Functional Class

	Involvement rates (per 100 mvm)	
Functional class	Fatal	Nonfatal injury
Rural Interstate	1.87	25.53
Rural-other principal artery	3.80	31.43
Rural minor arterial	6.49	41.65
Rural major collector	13.67	50.12
Urban Interstate	2.23	52.73
Urban-other principal artery	9.52	103.41
Urban local	27.79	55.59

KEY: mvm = million vehicle-miles.

SOURCE: Federal Highway Administration, "Monitoring Operations of Larger Dimension Vehicles Report," Jan. 14, 1987.

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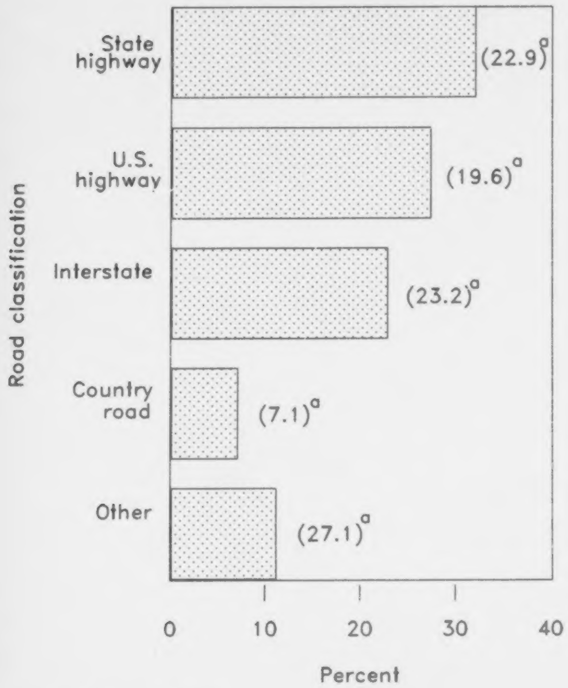
[66] The National Accident Sampling System driver classifications are somewhat confusing, since the classification categories do not appear to be mutually exclusive (e.g., an owner-operator could be trip leased in some instances).

[67] Motor Carrier Safety Assistance Program quarterly and annual reports.

[68] U.S. Department of Transportation, Federal Highway Administration, "Monitoring Operations of Larger Dimension Vehicles Report," unpublished manuscript, Jan. 14, 1987.

[69] Carsten, op. cit., footnote 38, table 5.

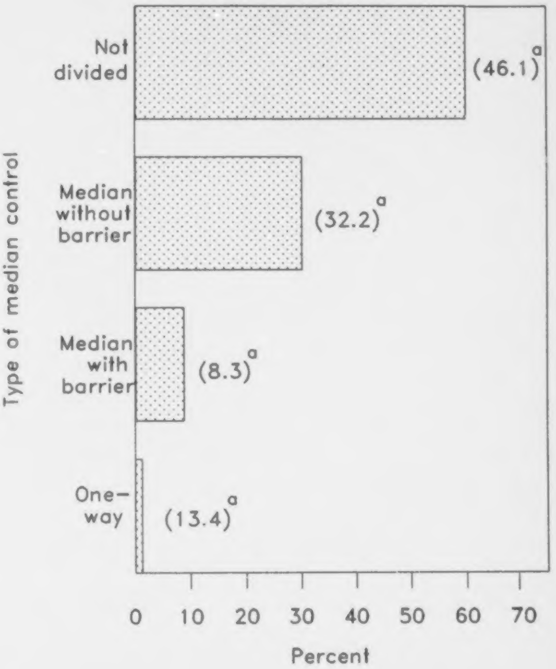
Figure 4-15.—Fatal Truck Accidents by Road Classification



[a]Percent of all truck accidents.

SOURCE: Office of Technology Assessment, 1988; based on National Accident Sampling System data, 1981-85 and Fatal Accident Reporting System data, 1983.

Figure 4-16.—Fatal Truck Accidents by Median Control



[a]Percent of all truck accidents.

SOURCE: Office of Technology Assessment, 1988; based on National Accident Sampling System data, 1981-85 and Fatal Accident Reporting System data, 1983.

For instance, fatalities are far more likely in accidents occurring on roads that are not physically divided and thus provide greater opportunity for head-on collisions (see figure 4-16). Roads with higher posted speed limits are significantly more likely to be the site of fatal truck accidents (see figure 4-17).

Slightly less than half the heavy truck accidents (49 percent) occur at intersections, and 80 percent of heavy truck accidents occur on roadway alignments classified as "straight" according to NASS (1981-85) data. Of all heavy truck fatality accidents, only 34 percent occur at intersections and 81 percent occur on straight aligned roads. Finally, 71 percent of nonfatal heavy truck accidents occur on level ground, 28 percent occur at grade, and only 1 percent at crests or in sags. Fatal heavy truck accidents have a similar pattern, except for a slightly higher proportion of fatal accidents at hill crests.

Lighting Conditions

The impact of lighting conditions on heavy truck accident rates is still imperfectly understood. Several studies find that the risk to truck safety is 1.5 to 2.0 times greater at night than in the daytime.[70] Table 4-9 indicates this is apparently true for rear-end accidents. Other studies report a higher truck accident rate in darkness during the summer, but a comparable accident rate for daylight and darkness during the winter season, or find no significant impact of lighting conditions.[71] However, there is

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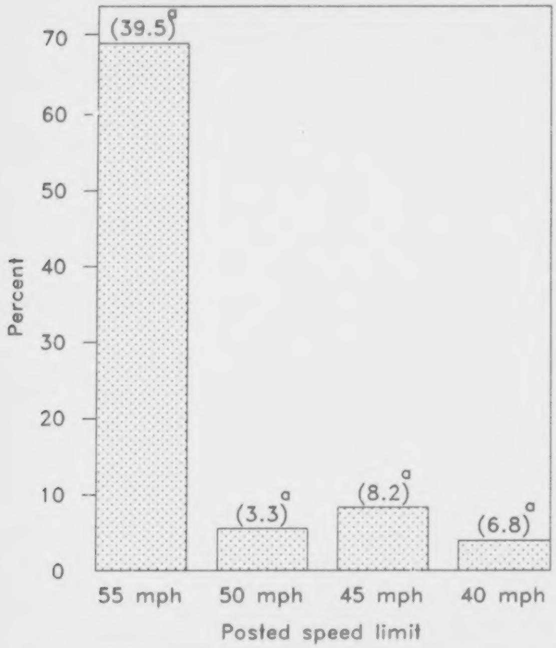
[70] Motor Vehicle Manufacturers Association, *Proceedings of the National Truck Safety Symposium*, op. cit., footnote 40.

[71] L. Strandberg, "On the Braking Safety of Articulated Heavy Freight Vehicles," *Symposium on the Role of Heavy Freight Vehicles in Traffic Accidents*, op. cit., footnote 7, vol. 2, p. 3-28; P.P. Jovanis and J. Delleur, "Exposure-Based Analysis of Motor Vehicle Accidents," *Transportation Research Record*, No. 910 (Washington, DC: Transportation Research Board, 1983), pp. 1-7; and Stein and Jones, op. cit., footnote 32, p. 12.

Figure 4-17.—Fatal Truck Accidents by Posted Speed Limits



aPercent of all truck accidents. (These numbers do not add up to 100 because not all posted speed limits are included.)

SOURCE: Office of Technology Assessment, 1988; based on National Accident Sampling System data, 1981-85 and Fatal Accident Reporting System data, 1983.

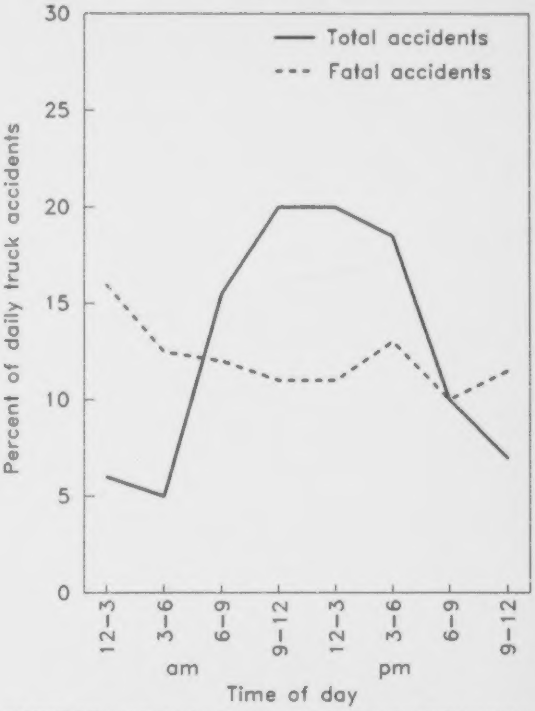
Table 4-9.—The Effect of Lighting Conditions on Rear-End Collisions

	Lighting condition	
Accident type	Daylight	Not daylight
Rear end	27.3%	72.7%
Other	49.1%	50.9%

SOURCE: Motor Vehicle Manufacturer's Association, *Proceedings of the National Truck Safety Symposium* (Washington, DC: June 1987), pp. 85-89.

a correlation between lighting conditions and fatalities; 50 percent of fatal accidents involving heavy trucks occur at night, in contrast to 27 percent of all heavy truck accidents (see figure 4-18). An official for the largest bus company indicated that nighttime accidents involving a bus running into a flatbed trailer truck were a major concern.[72]

Figure 4-18.—Combination Truck Accidents, by Time of Day



SOURCE: Office of Technology Assessment, 1988; based on National Highway Traffic Safety Administration analysis of Texas data, 1981-83.

Weather Conditions

Most heavy truck accidents (80 percent) occur in clear weather conditions (see figure 4-19). However, one study concluded that snowy weather is an important predictor of high accident rates for trucks, whereas rainy days have lower truck accident rates than do clear days.[73] Conspicuous by their absence as accident factors are splash, spray, or wind from passing trucks, likely due to difficulty in measuring this problem from accident reports. Moreover, research literature does not contain detailed discussion on this subject, although individual carriers, the American Trucking Associations, and others have recognized it as a significant problem. Additional study is needed to determine whether other characteristics, such as wet road conditions described in accident reports, are acting as a surrogate for splash and spray problems.

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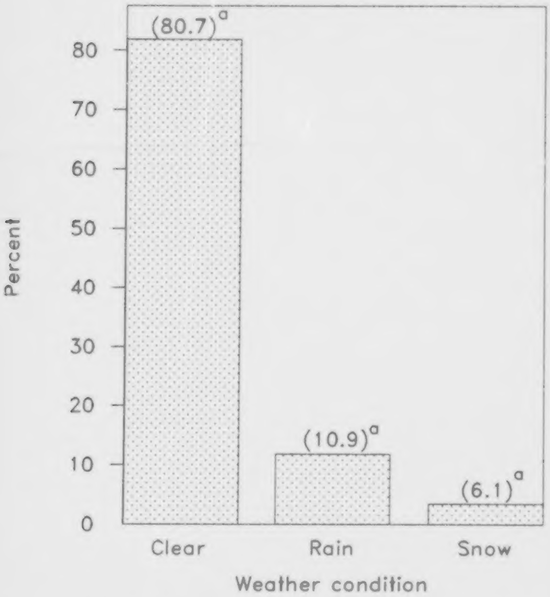
[72] Robert Forman, vice president for safety, Greyhound Bus Co., personal communication, February 1988.

[73] Jovanis and Delleur, op. cit., footnote 71.

Figure 4-19.—Fatal Truck Accidents by Weather Condition



[a]Percent of all accidents. (These numbers do not add up to 100 because not all posted speed limits are included.)

SOURCE: Office of Technology Assessment, 1988; based on National Accident Sampling System data, 1981-85 and Fatal Accident Reporting System data, 1983.

Photo credit: Tse-Sung Wu, OTA staff

The need for cars and trucks to share the road can create roadway hazards.

Sharing the Road

In a majority (77 percent) of multiple-vehicle accidents involving trucks, the truck is the striking unit.[74] A subset of the accidents where the truck is the striking unit may be attributable to passenger car maneuvers into a truck's path. Annual studies carried out over the past 10 years by the California Highway Patrol of heavy truck collisions place trucks at fault 43 to 53 percent of the time.[75]

An American Automobile Association-sponsored study of multiple-vehicle accidents involving heavy trucks in Michigan notes that the nontruck driver was considered at fault in 69 percent of fatal accidents and 49 percent of serious injury accidents requiring hospitalization.[76] These results suggest that, in addition to developing policies directed at improving the skills of truck drivers, educating the driving public about truck operations and safety requirements is a priority.

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[74] OTA calculations from the National Accident Sampling System (1981-85) data.

[75] National Highway Traffic Safety Administration, op. cit., footnote 36, p. 157.

[76] American Automobile Association, *Cars and Trucks: Sharing the Road Safely* (Washington, DC: December 1986).

CONCLUSIONS AND POLICY OPTIONS

Drivers, vehicles, road design characteristics, and ambient environmental conditions form a system in which motor carriers operate. Accident analysis highlights the interrelated nature of highway transportation. The accident studies referenced in this chapter underscore the complexity of this operating system and illustrate the difficulty of isolating single causal factors. Moreover, the precise role that each accident causal factor plays in heavy vehicle accidents is difficult to determine from current accident reports. **OTA finds that better understanding by State enforcement officers of accident causation and accident investigation methods is needed. Congress may wish to request the Department of Transportation to add accident investigation to the training provided under MCSAP.**

OTA analysis of Federal and State data shows that the three most common factors associated with heavy vehicle accidents are speed too fast for conditions, the training of the driver, and age and condition of the vehicle. The appropriate speed for conditions is a function of a variety of factors—highway and vehicle design, and environmental and human factors—that must be evaluated by the driver. Any one of them can create unsafe driving conditions. When heavy vehicles operate at speeds higher than appropriate for the road design, the vehicles are closer to their limits of braking and rollover performance capabilities. The time available to the driver to carry out emergency maneuvers is greatly reduced. Other factors, such as insufficient training, fatigue, road design inadequate for trucks, vehicle overloads, and poor visibility can all interact to limit safe speed. In view of the major role speed plays in fatal truck accidents and the many characteristics of heavy vehicles that make them more difficult and time consuming to stop safely, **Congress may wish to reexamine the decision to permit truck speeds of 65 mph at the discretion of States and to explore other methods of controlling excessive speeds for heavy vehicles.**

The heavy vehicle driver operates a complex piece of heavy equipment on roads designed for and occupied by smaller, more responsive vehicles. The driver is frequently the key factor in determining whether or not an accident occurs. However, truck drivers are often ill-prepared or inadequately trained for their jobs. Accident results indicate that better driver training could help reduce both the number and severity of accidents.

Congress may wish to consider requiring 1) that national guidelines for truck driver training be developed and validated; 2) that States must require evidence of training in a school or carrier program meeting the guidelines for the commercial vehicle driver's license; and 3) that the special handling characteristics of different vehicle configurations be a part of the guidelines. A key component of such a program is broad representation on the group developing the guidelines, including Federal and State regulatory and enforcement officers, scientists and researchers who study human fatigue factors, and representatives of training schools, carrier management, labor, and vehicle manufacturers.

A large number of heavy truck drivers involved in accidents have poor driving records, including speeding offenses and other unsafe maneuvers that are major causes of accidents. Young, inexperienced drivers are particularly at risk of an accident. There is a strong correlation between truck drivers under the influence of alcohol and increased accident likelihood and severity. Inspection and accident records show that carriers exempt from Federal safety regulations have more violations both for the condition of the vehicle and the qualifications of the driver.

Fatigue can play a major role in accidents, particularly early in a shift and after extended shift length. Older drivers are more affected by fatigue than younger drivers. Drivers of large trucks have shown significant increases in driving errors and decreases in driver alertness due to fatigue well within the current hours-of-service limit. Policy options addressing these driver-related factors may be found in chapter 6.

Vehicle design and operating characteristics have a significant impact on safety. Brake systems are most in need of attention, with brake maintenance a principal concern. Tire condition and performance are also key factors in safely handling a heavy truck. Override/underride accidents occur more often under conditions of reduced visibility, and trucks with underride protection are involved in fewer fatal accidents. Bobtails and combination trucks running empty pose higher accident risks, because of the complicated relationship between brake systems and truck loads. Poor handling and vehicle stability increase the likelihood of rollover, particularly for doubles operations. Policy options to address these issues directly are presented in chapter 5.

Studies of the relative safety of single and double combinations are not conclusive about differences in operating safety. **OTA finds that different safety problems are inherent in each design, and that driver training and experience with doubles and any other heavy vehicle with special handling characteristics can improve their safe operation.**

Truck occupants typically do not protect themselves by wearing seat belts. As a result, ejection and contact with the cab interior often occur, leading to serious injury or fatality. **Congress may wish to consider a requirement for heavy trucks to have substantial safety restraints and for drivers to use them.**

Furthermore, OTA concludes that stepped-up research is needed to improve cab design and safety. A public/private cooperative approach could provide a cost-effective way to integrate public health expertise and manufacturing product development.

Although roadway environment is recognized as a key part of the safety equation, U.S. and State highways are significantly overinvolved in fatal heavy truck accidents. Clear median markings and sturdy barriers are key factors in safety, and **Congress may wish to encourage DOT action on developing standards for such median devices on State and rural highways heavily used by trucks.**

Finally, the need for cars and trucks to share the roads safely makes education a top priority for DOT and State governments alike. The driving public must be made more fully aware of the handling characteristics of heavy trucks and the potentially life-threatening consequences of a multiple-vehicle crash.

Chapter 5

Technologies To Improve Motor Carrier Safety

Photo credit: Ohio State Highway Patrol

Most States have poorly designed highway segments where accidents are frequent; this one is known as Dead Man's Curve.

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Chapter 5

Technologies To Improve Motor Carrier Safety

Accident analyses and equipment research demonstrate that appropriate road design and vehicle technologies can help prevent highway accidents and reduce fatalities and injuries. Moreover, recent research shows that some aspects of highway design make driving today's heavy vehicles safely very difficult. Although new technologies cannot eliminate the effects of poor road conditions or unsafe driving, they can reduce the likelihood that a roadway mishap will result in a catastrophe.

This chapter examines the relationship between the vehicle, the driver, and the roadway environment, and describes the impact of highway design characteristics, vehicle equipment, and safety technologies on vehicle performance. As motor carriers of passengers, intercity buses operate under many of the same rules and regulations as the trucking industry. Certain aspects of truck safety are directly applicable to bus safety. Critical items such as brakes, tires, and lights are important for the safety of bus passengers and the motoring public and must be monitored by bus operators. Thus, although bus safety issues are not addressed separately in this chapter, many technology issues are applicable to that industry as well.

THE MOTOR CARRIER OPERATING ENVIRONMENT

Today's highway environment is substantially different than that of 10 years ago. The increase in automobile ownership, dispersed patterns of work and residence, and the speed and convenience of truck transportation have increased the use of the Nation's roads. Traffic on many highways in and around major metropolitan areas is already at or above design capacity, and road congestion is a fact of daily life for millions of Americans. The volume of automobile traffic, combined with large numbers of heavy trucks, has made accidents more likely simply by increasing the opportunities for accidents and exposing drivers to stressful driving conditions.

The impact of heavy traffic volume on safety is compounded by the fact that in recent years, passenger cars have become smaller and lighter while commercial trucks and some buses have become longer, heavier, and wider.[1] Combination trucks with 48-foot single trailers or twin 28-foot trailers are permitted on Interstate highways in all States under the Surface Transportation Assistance Act of 1982 (STAA). Segments of the motor carrier industry have mounted intense efforts to expand the network of roads and access points available to these vehicles. However, large portions of the Nation's highway system, particularly State roads, were designed primarily for automobiles, not for vehicles with the size and operating characteristics of heavy trucks. Moreover, the geometric design policy by which virtually all highway design is guided in the United States provides for only a slim margin of safety for large trucks.[2]

The STAA also created the National Truck Network, which includes the Interstate system and designated Federal-Aid Primary routes. The States must allow the heavy vehicles reasonable access between the National Truck Network and terminals and facilities for food, fuel, repairs, and rest. The American Association of State Highway and Transportation Officials (AASHTO), which establishes design guidelines for highways, ". . . has not adopted a design vehicle that reflects the STAA semitrailer combination."[3] Thus, only portions of the Interstate system and the National Truck Network were designed and constructed to accommodate the larger STAA vehicles.

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[1] Patricia F. Waller, "Heavy Truck Safety in a Changing Highway Transportation Environment," presented at the annual meeting of the American Society of Mechanical Engineers, Phoenix, AZ, Nov. 16-17, 1982, pp. 42-43.

[2] Robert Ervin et al., *Impact of Specific Geometric Features on Truck Operations and Safety at Interchanges* (Washington, DC: Federal Highway Administration, August 1985), p. 1.

[3] Federal Highway Administration, *Guide for Monitoring and Enhancing Safety on the National Truck Network* (Washington, DC: U.S. Department of Transportation, October 1986).

HIGHWAY DESIGN

Highway designs are "... developed after considering such factors as traffic volumes, vehicle mix, accident history, turning maneuvers and frequency, economics, and speed."[4] In principle, the design of a highway facility is determined by "... the largest design vehicle likely to use that facility with considerable frequency or a design vehicle with special characteristics that must be taken into account."[5]

Highway features affect at least four major safety factors including:

- the ability of a driver to maintain vehicle control and identify hazards;
- the number and type of opportunities for conflicts between vehicles;
- the consequences of an out-of-control vehicle leaving the travel lane; and
- the behavior and attentiveness of the driver, particularly the choice of travel speed.

However, the contributions of even the best highway design to safe vehicle operation can be counterbalanced by variables such as weather, lighting, and traffic.[6] This section examines the interaction between road design geometry and heavy trucks, highlighting potential low-cost countermeasures to dangerous roadway situations.

Road Geometry

AASHTO design standards guide the construction and reconstruction of highways across the country. In most cases, these guidelines were formulated for the passenger car, the dominant vehicle on the road.[7] Stopping sight distances on hillcrests, for example, were based on the locked-wheel performance of passenger car tires, and the passing sight distance standards for passing lanes were based on car acceleration capabilities.[8] AASHTO standards for the Interstate highway system can accommodate STAA trucks. However, States are free to choose the design vehicle for highways within their borders, and in fact, used standards for smaller vehicles for many of the segments of the Nation's road network that are heavily used by trucks.[9] Thus, despite design efforts aimed at minimizing safety hazards, certain features of the highway system are contributing causes for accidents involving heavy vehicles.

Highway standards are evolutionary, and change occurs very slowly. Moreover, the relationship between safety and highway design features is still poorly understood, because statistical correlations have not been determined.[10] Even after new standards are developed, existing roads may not adequately accommodate heavy trucks. Recently released AASHTO highway design standards do not provide fully for the largest trucks authorized by the STAA, for example, since 102-inch semitrailers require wider lane widths than the new standards provide on curves.[11] In addition, automobiles need longer passing sight distances and more time to overtake longer tractor-trailer combinations. To make matters even more confusing, the current design manual offers 14 different design vehicles from which States may choose.[12]

Seven areas of AASHTO's "Policy on Geometric Design of Highways and Streets" pose concerns for truck operations, including:[13]

- sight distance and no-passing zones,
- grades and climbing lanes,
- intersection design and operation,

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[4] Ibid., p. 16.

[5] American Association of State Highway and Transportation Officials, *A Policy on Geometric Design of Highways and Streets* (Washington, DC: 1984), pp. 19-20.

[6] Transportation Research Board, *Designing Safer Roads: Practices for Resurfacing, Restoration, and Rehabilitation*, Special Report (Washington, DC: National Research Council, 1987), p. 77.

[7] Robert Ervin et. al., "Truck Control Problems Posed by the Design of Highway Ramps," *Vehicle Highway Infrastructure: Safety Compatibility*, P-194 (Warrendale, PA: Society of Automotive Engineers, Inc., February 1987), p. 29.

[8] P.S. Fancher, "Sight Distance Problems Related to Large Trucks," *Symposium on Geometric Design for Large Trucks*, Transportation Research Record 1052 (Washington, DC: Transportation Research Board, National Research Council, 1986), pp. 29-30.

[9] Transportation Research Board, *Twin Trailer Trucks: Effects on Highways and Highway Safety*, Special Report 211 (Washington, DC: National Research Council, 1986), p. 179.

[10] Transportation Research Board, op. cit., footnote 6.

[11] Transportation Research Board, op. cit., footnote 9, p. 180.

[12] Larry King, Office of Engineering, Geometric and Roadside Design Branch, Federal Highway Administration, personal communication, May 10, 1988.

[13] J.W. Hall, "Introduction," *Symposium on Geometric Design for Large Trucks*, op. cit., footnote 8, p. 1.

- interchange and ramp design,
- roadside design and traffic barriers,
- traffic control device usage, and
- safety.

For example, one basic AASHTO design vehicle—tractor and an approximately 40-foot trailer—was intended to serve as the model for designing rural, two-lane intersections. However, this vehicle was subsequently widely used for designing intersections in urban areas across the country. Tractors with 48-foot or longer trailers making turns in such intersections override all available clearance space between travel lane edge and road edge.[14]

Intersections are potentially dangerous in other ways as well. In a turn, the wheels on the rear axle of a vehicle follow a track inside the path of the wheels on the front axle—a phenomenon called off-tracking. Tractor-trailers making turns begin to off-track inwardly at slow speeds and trailers often encroach on intersecting traffic lanes, striking other vehicles (see figure 5-1). Low-speed off-tracking can be reduced or eliminated by mechanisms that steer the wheels of each axle, an expensive alternative generally reserved for specialized equipment. Current intersection designs do not satisfactorily accommodate the effects of low-speed off-tracking, especially for the 48-foot semitrailers that are now basic equipment.[15]

Photo credit: Michael Hines, OTA staff

Large trucks can be hazardous to other vehicles at intersections because the trailers cannot make sharp turns.

Highway interchange ramps, even those on many Interstate highways, are especially hazardous locations for trucks.[16] AASHTO geometric design standards for ramps are based almost exclusively on passenger car dimensions.[17] While negotiating curves at high speeds, commercial vehicles exhibit outward off-tracking—each outside wheel of an axle travels a path outside the path of the preceding outside wheel. The outside wheels on a trailer may strike a curb or other object close to the roadway, damaging the curb or object or, worse, causing rollover.

The National Highway Traffic Safety Administration (NHTSA) reports that high-speed off-tracking is common, an important safety issue as the population of multiple-trailer combination vehicles increases.[18] No studies have been conducted regarding combination vehicle configuration and accidents due to off-tracking.

Particular ramp design parameters make it all too easy for a truck driver to lose control of his vehicle. A truck entering a curving highway entrance or exit ramp at high speed must slow down rapidly on a curving roadway, placing a truck at immediate risk for a jackknife or rollover accident.[19] Compound curves, where the degree of curvature varies throughout the curve, present particularly difficult challenges.[20] Drivers often do not understand the dynamic characteristics of the vehicle and the interaction with the changing highway geometry. They thus do not adequately adjust their speed for the situation and are consequently moving too fast

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[14] Robert Ervin, acting director, University of Michigan Transportation Research Institute, personal communication, Jan. 13, 1988.

[15] John W. Hutchinson et al., "Highway Factors in Truck Wrecks," *Proceedings, Symposium on Accommodation of Trucks on the Highway: Safety in Design* (Nashville, TN: American Society of Civil Engineers, May 11, 1988).

[16] Snehamay Khasnabis, "Operational and Safety Problems of Trucks in No-Passing Zones on Two-Lane Rural Highways," *Symposium on Geometric Design for Large Trucks*, op. cit., footnote 8, p. 38; and Federal Highway Administration, *Longer Combination Vehicle Operations in Western States* (Washington, DC: U.S. Department of Transportation, October 1986), p. III-7.

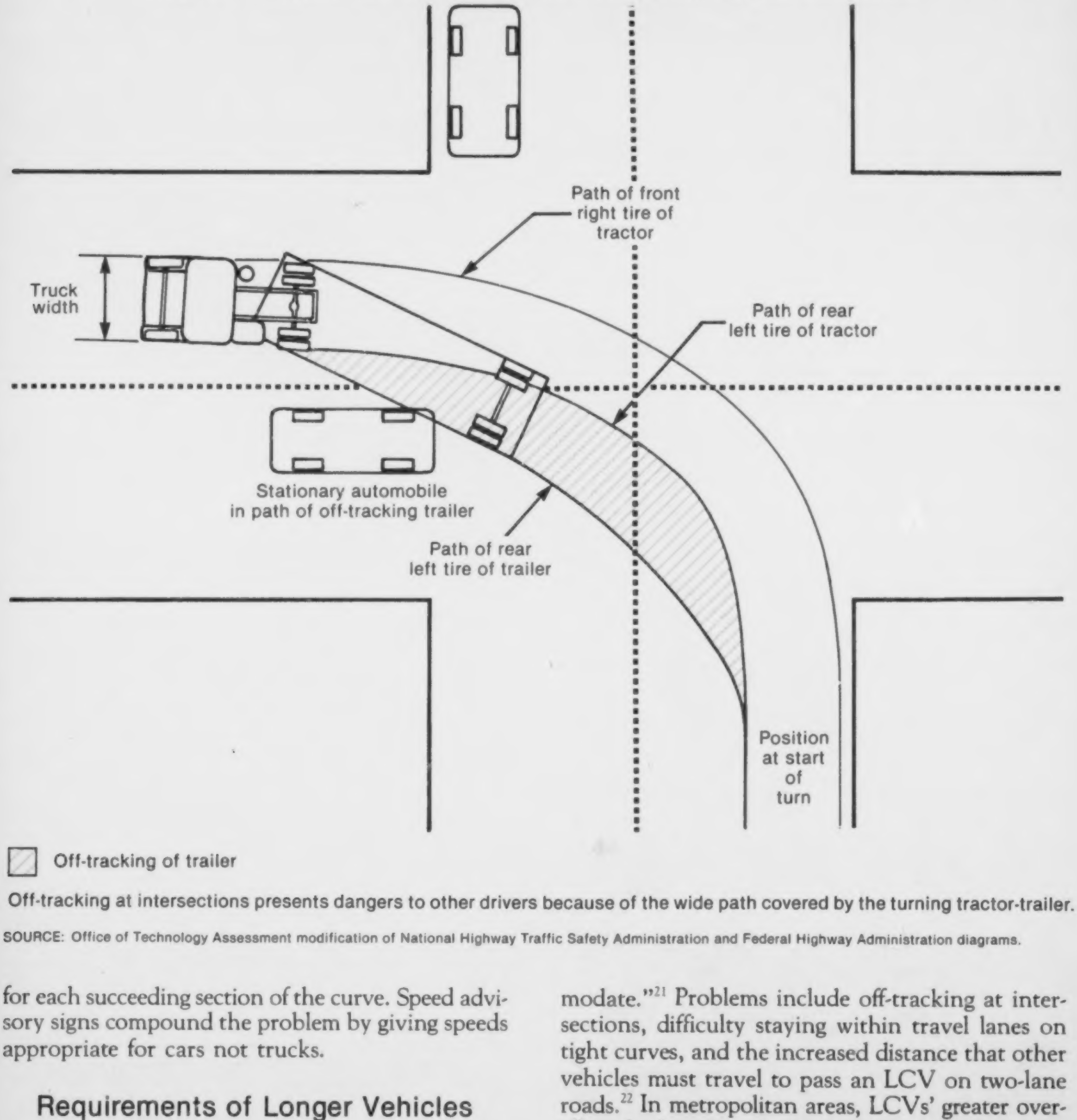
[17] Ervin et al., op. cit., footnote 7, p. 29.

[18] National Highway Traffic Safety Administration, *Heavy Truck Safety Study*, prepared in response to the Motor Carrier Safety Act of 1984 (Washington, DC: U.S. Department of Transportation, January 1987), p. 132.

[19] Ervin et al., op. cit., footnote 2, p. 118.

[20] Justin True, Federal Highway Administration, personal communication, Oct. 21, 1987.

Figure 5-1.—Typical Low-Speed Inward Off-Tracking Problem at an Intersection


Path of front right tire of tractor
Truck width
Path of rear left tire of tractor
Stationary automobile in path of off-tracking trailer
Path of rear left tire of trailer
Position at start of turn
▨ Off-tracking of trailer

Off-tracking at intersections presents dangers to other drivers because of the wide path covered by the turning tractor-trailer.

SOURCE: Office of Technology Assessment modification of National Highway Traffic Safety Administration and Federal Highway Administration diagrams.

for each succeeding section of the curve. Speed advisory signs compound the problem by giving speeds appropriate for cars not trucks.

Requirements of Longer Vehicles

Drivers of longer combination vehicles (LCVs)—Rocky Mountain Doubles, turnpike doubles, and triples (see figure 5-2)—also confront major driving challenges due to highway design. LCV dimensions "... greatly exceed the dimensions of vehicles that even Interstate highways were designed to accommodate."[21] Problems include off-tracking at intersections, difficulty staying within travel lanes on tight curves, and the increased distance that other vehicles must travel to pass an LCV on two-lane roads.[22] In metropolitan areas, LCVs' greater overall trailer length and inherent handling characteristics further complicate safe operations. Urban freeways also have more crowded travel lanes, reducing distances between vehicles and increasing the need

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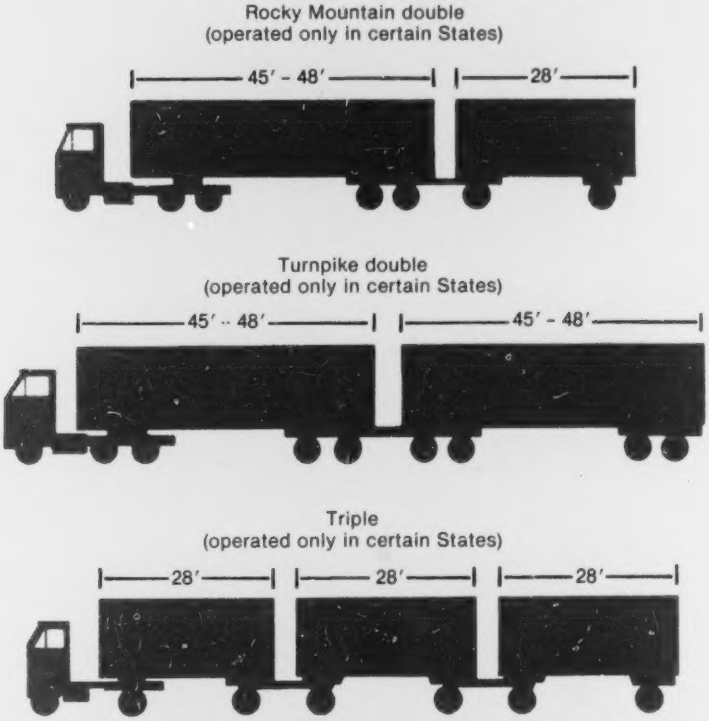
[21] Federal Highway Adminstration, op. cit., footnote 16, p. V-8.

[22] Ibid., p. III-8.

Figure 5-2.—Longer Combination Vehicles


Rocky Mountain double
(operated only in certain States)

Turnpike double
(operated only in certain States)

Triple
(operated only in certain States)

Lengths shown are typical; shorter or longer lengths are possible depending on carriers' needs and State laws.

SOURCE: Office of Technology Assessment, 1988; based on American Trucking Association, Inc.

for rapid steering movements.[23] Abrupt turning movements by the driver, such as changing lanes to reach an exit or to avoid slow traffic ahead, create special dangers from rearward amplification and swaying of the rear trailer.

States that permit LCVs provide for these large vehicles in several ways to keep them off highways that cannot accommodate them. The most common method is to construct large truck parking or exchange lots at intervals on turnpikes and Interstate highways. Carriers that use turnpike doubles or triples use these lots as assembly and break up points for the LCVs. Tractors haul single trailers from origins off the Interstate to the lot where the trailers are hitched in tandem to a single tractor for the long haul to a destination lot. There the trailers are broken apart and either hitched to another tandem for a further leg or attached to an individual tractor and hauled to the final destination.

A segment of the trucking industry is pushing for increased productivity through expanded use of LCVs. However, safety problems and pavement deterioration at the edge of the roadway caused by off-tracking are likely to result if large numbers of LCVs use inadequate road segments for increased off-highway access.[24] Although research is currently underway to identify major shortcomings in road design, immediate, wholesale reconstruction of the road network is not feasible. Since many longer trucks are here to stay, some form of interim safety countermeasures are prudent public investments.

Countermeaures include selective improvements at high-risk locations, determined by traffic volume and accident analysis and aimed at reducing accident frequency and severity. Highway safety can be improved during reconstruction by correcting deficiencies in:[25]

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[23] Ibid., p. III-7.

[24] Ibid., p. III-16.

- lane and shoulder widths,
- roadsides and sideslopes,
- bridge entrance widths,
- road horizontal alignments,
- sight distances,
- intersections,
- pavement edge drops,
- pavement surface conditions,
- posted speeds for ramps and curves, and
- sign design, height, and location.

Warning signs that communicate timely and specific safe speed information for trucks on highway entrance or exit ramps are relatively inexpensive countermeasures. Outer curb removal on interchange ramp curves can reduce trailer rollovers. Other safety efforts, such as runaway truck escape ramps, grade-climbing lanes, and better pavement markings can also reduce hazards inherent in truck operations. These vary in cost and scope and illustrate actions that State and local governments can undertake.

Some State highway departments have begun to address the special problems of large, heavy trucks in mixed traffic. The California Department of Transportation adapted a computer model to compare data representing the geometry of State roads against the operating parameters of large trucks. The model identified portions of the State road network where STAA trucks would have difficulty negotiating the existing road geometry safely. California chose to use special signs to designate the highways where STAA trucks could travel.[26] The trucking industry found the designated network overly restrictive; efforts to effect a compromise are under way.

Other jurisdictions are considering constructing exclusive truck-use lanes on congested highways in urban areas. The State of Texas has undertaken a feasibility study for such lanes focused on the I-35 corridor between Dallas and San Antonio. The study showed that present volumes on 90 percent of the corridor did not warrant exclusive truck-use lanes. The researchers used a computer program to evaluate the study corridor and obtain information on volume-to-capacity ratios and effective median width. Congested segments of the corridor near urban areas contained insufficient roadway median space for truck lanes. However, one of the six design options, elevated truck lanes, was suitable for some segments of the corridor.[27]

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[25] Transportation Research Board, op. cit., footnote 6, pp. 105-106.

[26] John Van Berkel, chief, Truck Operations Branch, California Department of Transportation, personal communication, Nov. 12, 1987.

[27] Dan R. Middleton et al., "Moving Analysis Program to Evaluate Geometric and Operational Feasibilities of Exclusive Truck Facilities," *Geometric Design and Operational Effects*, Transportation Research Record 1122 (Washington, DC: Transportation Research Board, 1987), pp. 132 and 141.

VEHICLE TECHNOLOGIES

Accident data analyses suggest that improvements in several areas of equipment design and maintenance could enhance heavy vehicle safety. The braking system is foremost among these safety technologies, and brake systems are especially problematic for tractor-trailer combinations. Such issues as handling and steering, occupant protection, visibility and lighting, and splash and spray control also are important for buses and combination and straight trucks. Current technologies are discussed in the following sections. The truck of the future is likely to incorporate advanced electronics, such as monitors for vehicle operation, vehicle controls, drivetrain controls, information displays, electrical systems, comfort and convenience features, and driver performance aids.[28] However, until these technologies are proven and cost-effective, they will not be readily adopted by the industry.

Truck Brake Systems

U.S. Department of Transportation (DOT) inspection data show that the most frequent violation on trucks pulled out of service is poorly maintained or misadjusted brakes. Moreover, OTA found widespread misunderstanding particularly among owner-operators, about the proper installation and maintenance of brakes. Three basic air brake foundation brake designs are currently fitted to heavy trucks (see figure 5-3): cam brakes, wedge brakes, and disc brakes. Over 90 percent of heavy-duty, air braked vehicles use an S-cam drum brake, which is operated via a push rod from a diaphragm air chamber (see figure 5-4). The wedge drum brake has built-in automatic adjusters.

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[28] *Automotive News*, "Heavy-Duty Electrucks," Nov. 24, 1986, p. D14.

The disc brake provides improved resistance to fade, comes equipped with automatic slack adjusters, and operates more effectively at high temperatures than drum brakes.[29] Disc brakes on trucks presently cost more ($250-$500 per axle) than drum brakes and account for less than 3 percent of the truck brake market.[30] Early problems with truck disc brakes included premature pad wear and rotor failure due to cracking, conditions resulting from design problems and incompatibilities between disc and drum systems.[31] Although many operators of fleets comprised of straight trucks are long-time disc brake users, compatibility problems need to be resolved before disc brakes can be widely used on tractor-trailers. Correct driving practices are also a key issue.

Brake System Performance

Brake performance is generally evaluated in two dimensions—stopping distance and stability. The ability of truck braking systems to perform according to these criteria has been tested by NHTSA using driver-modulated stops (driver applies brakes to just below wheel lockup and modifies the pressure until the vehicle comes to a complete stop). As figure 5-5 shows, all trucks, regardless of configuration and load, take longer to stop from a speed of 60 miles per hour (mph) than passenger cars and buses. Loaded tractor-trailers perform relatively well, better than empty vehicles, particularly bobtail tractors, since brake systems are typically optimized for loaded conditions. Very short wheelbase bobtail tractors require as much as 500 feet to stop, almost three times more than a passenger car.

Truck brakes must be sized to handle vehicle loaded weights that can be up to three times greater than vehicle empty weights. For large combination vehicles, the relationship between a trailer's brakes and those of the tractor are critical; incompatible systems create unbalanced braking and excessive wear.[32]

Tractors and trailers are manufactured separately by different companies in separate industry segments. Broad ranges of performance exist for tractors, trailers, and other components, and some of the ranges may be incompatible with other parts of the vehicle system.[33] Current NHTSA requirements for air brake systems (tractor-trailers have air brakes on each axle) require brake actuation in 0.45 seconds for tractors and 0.30 seconds for trailers.[34] However, many safety experts and industry representatives believe that tractor-trailers should have more evenly matched or synchronized brake actuation times and antilock systems to help maintain stability and control.

The effectiveness of truck brakes is determined by many elements within the braking system. They include brake system capacity, brake force distribution, application timing, limiting valves, linings, and maintenance and adjustment.

Brake System Capacity

Truck brakes rely on friction and brake lining material to provide sufficient torque to slow and stop a vehicle weighing as much as 80,000 pounds within a reasonable distance. Repeated or continuous brake use (such as on long or steep hills) generates high temperatures that cause the brake linings to lose effectiveness either from fading or disintegration.[35] **Thus, on a 6-percent grade, an 80,000-pound tractor-trailer requires 167 times more braking power than a 3,000-pound passenger car, even**

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[29] Chris Shapeley, "A Comparison of Car and Truck Safety," *Proceedings, Symposium on Accommodation of Trucks on the Highway: Safety in Design*, op. cit., footnote 15.

[30] *Fleet Owner*, "Fleets Hold Back From the Next Brake," July 1983.

[31] Ian Jones, "Truck Air Brakes—Current Standards and Performance," presented at the 28th Annual Conference of the American Association for Automotive Medicine, Denver, CO, October 1984, p. 12.

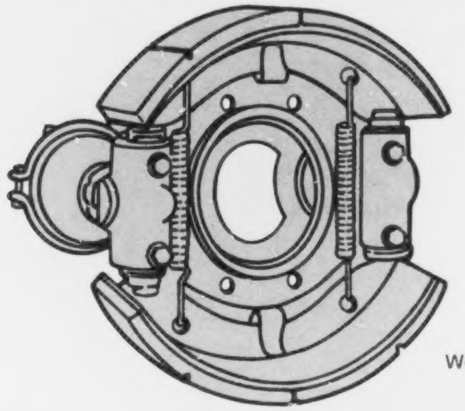
[32] Insurance Institute for Highway Safety, *Big Trucks* (Washington, DC: 1985), p. 12.

[33] National Highway Traffic Safety Administration, op. cit., footnote 18, p. 57.

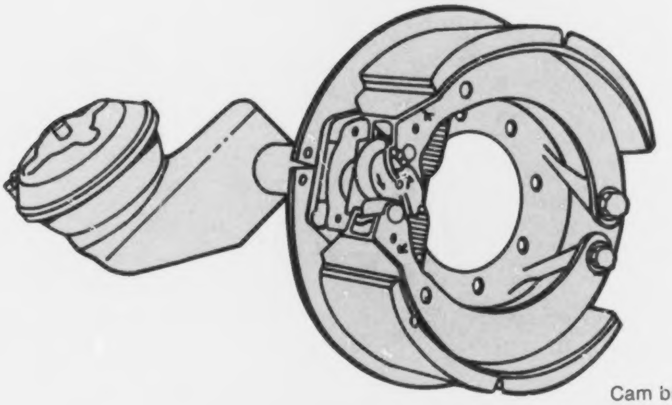
[34] 49 CFR 571.121.

[35] National Highway Traffic Safety Administration, op. cit., footnote 18, p. 59.

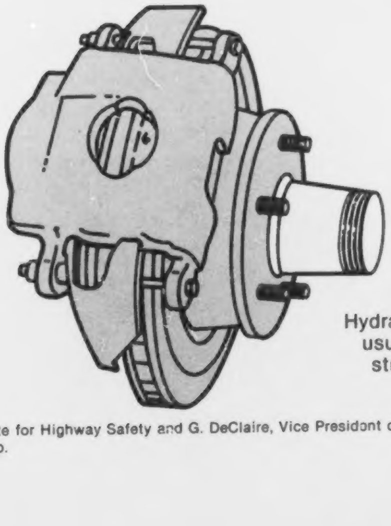
Figure 5-3.—Types of Brakes for Medium and Heavy Trucks



Wedge brake



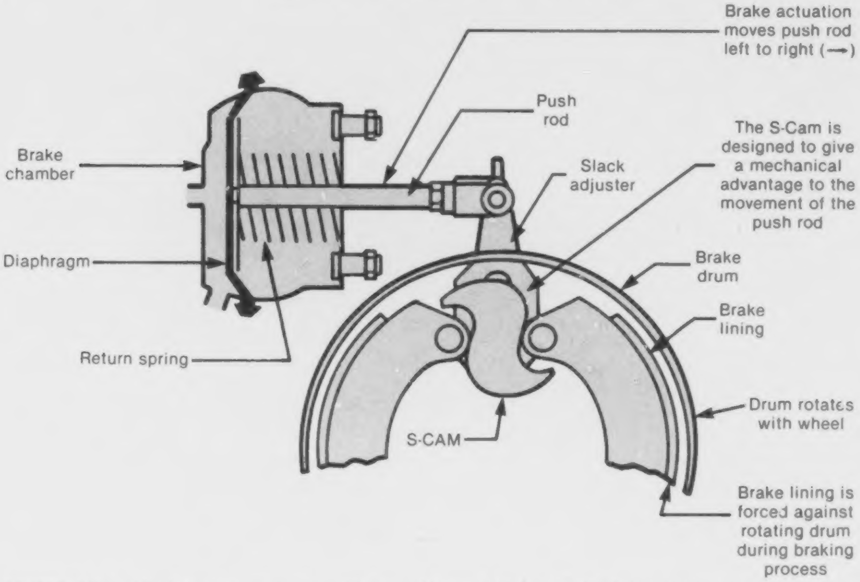
Cam brake



Hydraulic disc brake usually found on straight trucks

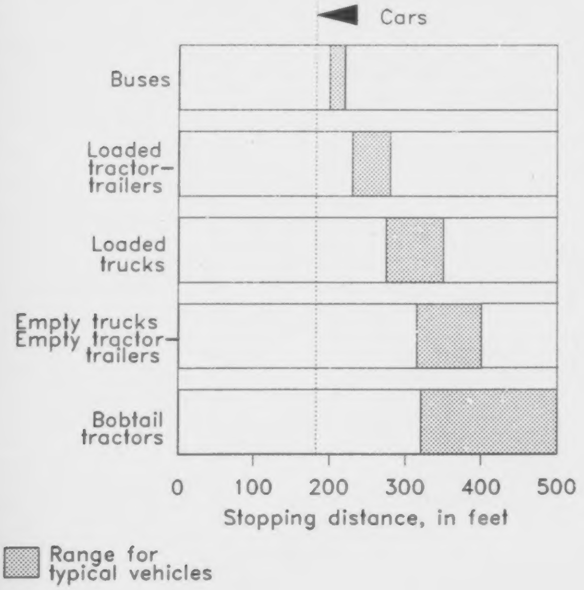
SOURCE: Insurance Institute for Highway Safety and G. DeClaire, Vice President of Research and Engineering, Rockwell International Corp.

Figure 5-4.—Cam Brake Assembly


Brake actuation moves push rod left to right (→)
Push rod
The S-Cam is designed to give a mechanical advantage to the movement of the push rod
Slack adjuster
Brake chamber
Diaphragm
Brake drum
Brake lining
Return spring
Drum rotates with wheel
S-CAM
Brake lining is forced against rotating drum during braking process

SOURCE: Office of Technology Assessment modification of National Highway Traffic Safety Administration diagram.

Figure 5-5.—Stable Stopping Distances of Heavy Air Braked Vehicles From 60 mph on Dry Road



SOURCE: Office of Technology Assessment, 1988; based on National Highway Traffic Safety Administration data, 1987.

though the tractor-trailer weighs only 27 times more. (See figure 5-6.)[36]

To achieve better fuel efficiency, truck manufacturers have worked to reduce vehicle rolling resistance and improve aerodynamics. However, this puts greater stress on truck braking systems. **Current truck brakes do not have sufficient heat capacity for all braking requirements, and brake thermal loads may increase in the future. Brake retarders could be useful in lessening thermal loads on brakes, especially in hilly and mountainous terrain.** (See box 5-A.)

Brake Force Distribution

Ideally, distribution of braking energy among the truck's axles matches the load placed on it. However, in normal truck operations, load size and weight distribution vary by shipment, and nothing in current brake systems modulates brake force distribution in reaction to changes in loading. In general, if the braking forces on the tractor and trailer are poorly matched to the way the load being carried

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[36] Ibid., p. 61.

Photo credit: Tse-Sung Wu, OTA staff

A driver demonstrates how to connect brakes when attaching a trailer to a cab.

is distributed, the brake components can overheat leading to fading, disintegration, or even fire in very extreme cases. Until new brake technologies become standard equipment on new vehicles, achieving brake force distribution and balance compatible with each of the ways in which trucks can be loaded and operated will be difficult.[37]

One method of redistributing brake force as loading changes is a load proportioning valve. The simplest load proportioning device is one that senses whether there is a connection between a tractor and trailer. If the tractor is operated without a trailer, braking effort is shifted to the steering axle from the drive axle. The proportioning valves can reduce the stopping distance for a bobtail tractor moving at 60 mph from 500 feet to about 300 feet. Domestic manufacturers offer this relatively simple and inexpensive ($50) device[38] as standard equipment on some models and as optional equipment. The device cannot discriminate between a loaded and an empty trailer and benefits only a bobtail tractor.

More sophisticated load proportioning devices are widely used on heavy vehicles in Europe, in part because European Community regulations for truck brakes cannot be met without such a system. These devices continously monitor the load on each axle by measuring the deflection of the suspension system.

Brake Application and Release Timing

Brake application and release times need to be as quick as practical. Although long release times do not affect stopping distance, they do make it difficult to release the vehicle's brakes quickly in the

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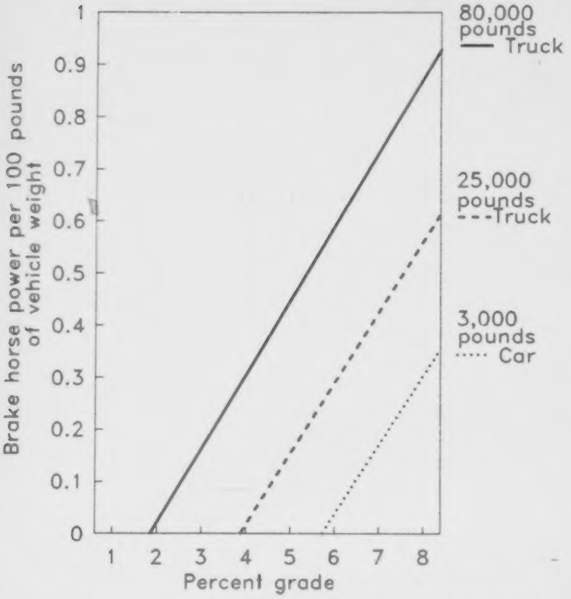
[37] Ibid., p. 91.

[38] Ibid., p. 91.

Figure 5-6.—Braking Power Necessary To Maintain 55 mph v. Percent Grade



SOURCE: Office of Technology Assessment, 1988; based on National Highway Traffic Safety Administration data, 1987.

event that the driver overbrakes and locks the wheels. The longer the trailer wheels remain locked, the more likely that trailer swing or jackknife can occur.

Current Federal Motor Vehicle Safety Standard (FMVSS) regulations specify that tractor brakes may take no longer than 0.45 seconds to actuate once the pedal is pushed, but give no minimum time. Consequently, tractor manufacturers have designed their brake systems for the worst case—the longest wheelbase tractor with the slowest actuation times.[39] However, the actuation times may be much less than the maximum, and the tractor brakes may actuate so quickly that the trailer cannot respond effectively. Trailer manufacturers have been unable to design an air brake system that will actuate at the same time as that of the tractor. (See figure 5-7.) Requiring a minimum actuation time as well as a maximum could ensure that tractor brakes do not actuate too quickly—prior to the trailer brakes—putting the combination out of balance. One industry group holds that a minimum brake actuation time for tractors should be set at 0.30 seconds,[40] and trailer brakes should also actuate and release within a certain time.

NHTSA has addressed several of these problems through a notice of proposed rulemaking[41] The goal is a more effective timing balance without an increase in complexity of the system. The notice proposes changing the existing brake application and release timing requirements for trucks, tractors, and trailers, and establishing new timing requirements for the control-line coupling between lead and trailing units.

Box 5-A.—Brake Retarders

A brake retarder is an auxiliary braking device that can help a truck maintain a steady, controlled speed on grades without the service brakes and slow down before it enters interchange ramps or turns. Retarders can reduce brake wear and fade and the potential for brake failure in emergencies.[1]

There are four main types of retarders: engine, exhaust, hydraulic, and electric. Each functions differently, but all reduce truck speed through means other than service brakes. An engine retarder operates by changing valve timing and causing the engine to compress air on the compression stroke during otherwise normal engine functioning. Absorbed energy is then released from the engine by the opening of the exhaust valve at the end of the compression stroke.[2]

Retarders can reduce brake maintenance costs in many heavy vehicle operations, especially those in mountainous areas. One truckload sector carrier experimented with retarders on several trucks, and found that trucks without retarders had substantially greater brake wear.[3] However, training is recommended for drivers, because retarders can cause the drive axle to lock if brakes are applied too quickly, especially on wet pavement.

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[1] National Highway Traffic Safety Administration, *A Professional Truck Driver's Guide On the Use of Retarders* (Washington, DC: U.S. Government Printing Office, January 1985), pp. 2-3.

[2] Ibid., p. 5.

[3] Paul Richards, "Retarders Giving Brakes a Chance," *Commercial Carrier Journal*, December 1987, p. 64.

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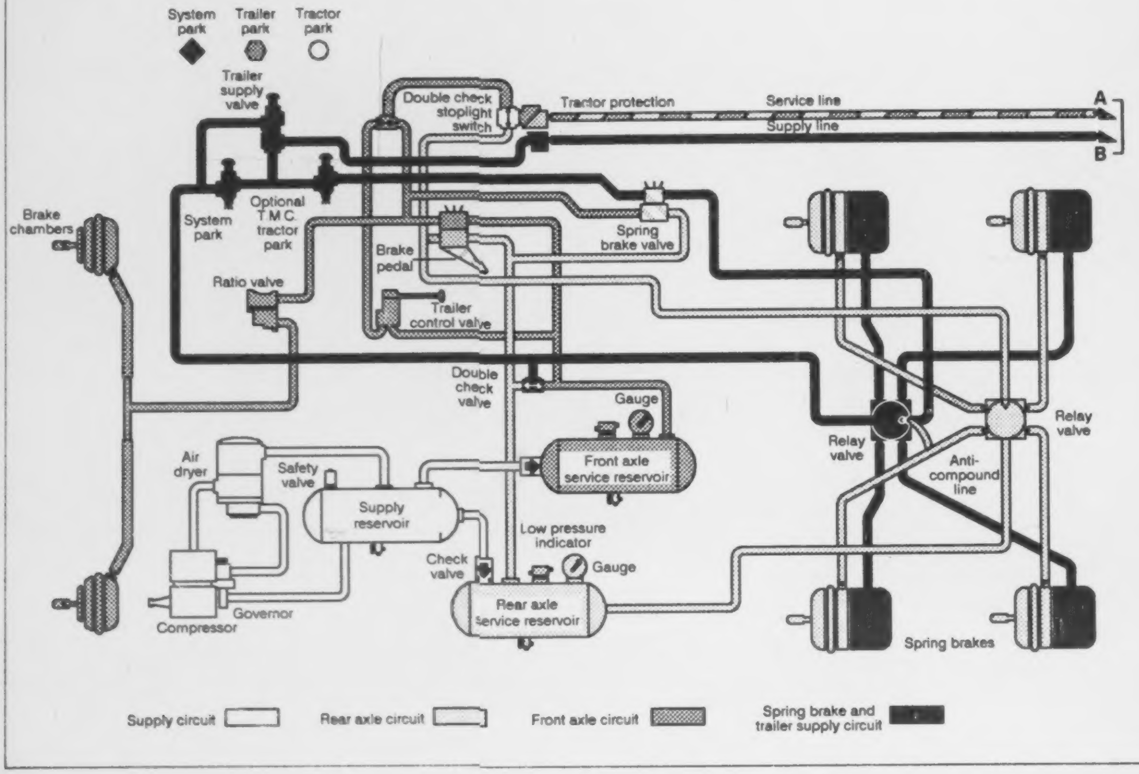
[39] Larry Strawhorn, American Trucking Associations, personal communication, Mar. 4, 1987.

[40] American Trucking Associations, Comments on NHTSA Docket No. 85-07, Notice 1, 50 *Federal Register* 20113 (Dec. 30, 1985).

[41] Docket No. 85-07, Notice 1, Air Brake Systems, 50 *Federal Register* 20113 (May 14, 1985).

Figure 5-7.—Tractor-Trailer Brake System Schematic Diagram

Truck/Tractor System

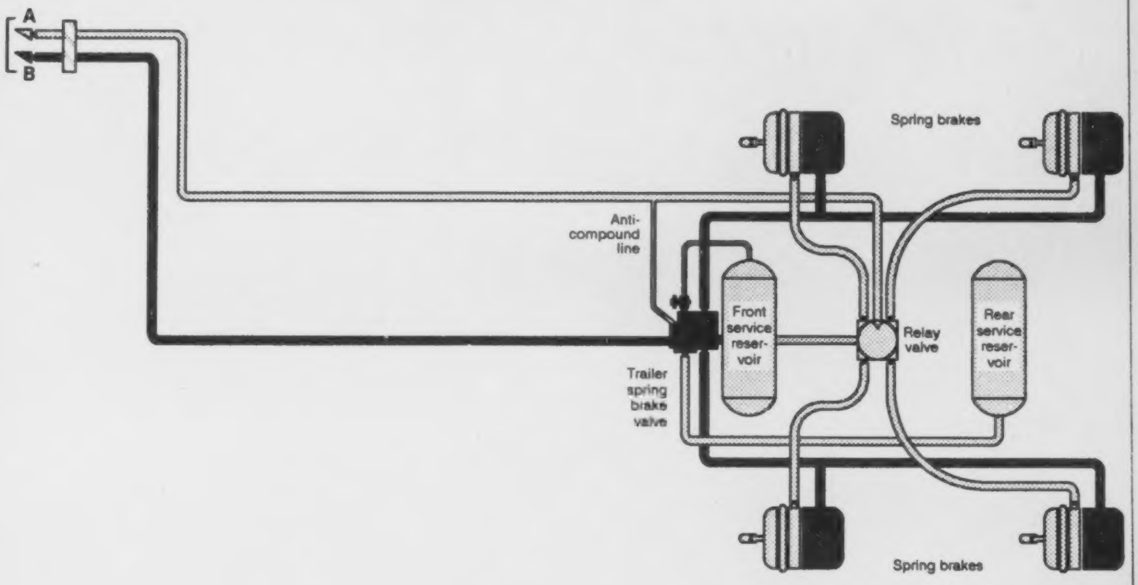

System park
Trailer park
Tractor park
Trailer supply valve
Double check stoplight switch
Tractor protection
Service line
Supply line
A
B
Brake chambers
System park
Optional T.M.C. tractor park
Brake pedal
Spring brake valve
Ratio valve
Trailer control valve
Double check valve
Gauge
Relay valve
Relay valve
Anti-compound line
Air dryer
Safety valve
Supply reservoir
Front axle service reservoir
Low pressure indicator
Check valve
Gauge
Rear axle service reservoir
Governor
Compressor
Spring brakes
Supply circuit
Rear axle circuit
Front axle circuit
Spring brake and trailer supply circuit

Antilock Brakes

Antilock brakes can prevent the wheels from locking and reduce the potential for directional instabilities that often lead to jackknifing and overturning. An antilock system consists of devices attached to each truck axle that sense when a wheel begins to lock and momentarily release the brakes. As early as 1977, a NHTSA study comparing trucks fitted with antilock systems with those without, found that jackknifing accidents were reduced by 29 percent. Second-generation antilock systems are now being developed using recent advances in microprocessor technology. Although no widespread domestic production of antilock systems exists at this time, at least one domestic manufacturer is already installing a European antilock system on U.S. vehicles.

Antilock technology has progressed sufficiently so that many safety advocates are calling for a regulation requiring antilock brakes on all new equipment. Brake and tractor manufacturers have developed tractor-only, tandem-axle systems that they believe will be compatible with U.S. industry operations. However, the lesson of FMVSS 121 (see box 5-B) is that the reliability of antilock system technology must be proven before antilock brakes can be mandated. In cooperation with antilock suppliers, truck manufacturers, and motor carriers, NHTSA is testing equipment with antilock systems to acquire performance, reliability, maintainability, and cost data.

Trailer System



Automatic Limiting Valves

An automatic brake pressure limiting valve (ALV) is used by some operators to reduce brake application pressure to the front axles of combination-unit trucks under all but panic stops. Steering wheel pull during braking is related to poor front brake adjustment and maintenance. Brake experts and manufacturers contend that ALVs may cover up front brake maintenance problems, degrade stopping capability when the vehicle is operating empty or on slippery roadways, and burden other brakes on downhill grades. Proponents among carriers hold that limiting valves on standard front brakes keep the front axle from locking or the vehicle from pulling to one side during a sudden brake application under emergency stopping conditions.[42]

Brake Maintenance and Adjustment

Appropriate brake adjustment is essential for adequate braking for current systems. NHTSA tests conducted on brakes at different adjustment levels show that stopping distance increases as brake adjustment deteriorates (see figure 5-8). Adjustment of S-cam drum brakes is especially critical because

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[42] Larry Strawhorn, American Trucking Associations, quoted in Paul Richards, "Point/Counterpoint: Front Brake Limiting Valves," *Commercial Carrier Journal*, December 1987, p. 59.

Box 5-B.—Rulemaking History

Approximately 20 years ago, the National Highway Traffic Safety Administration (NHTSA) began its rulemaking effort to set standards for air brake systems.[1] Although antilock devices were not explicitly required in its proposed standard, NHTSA established criteria for them and maintained that their performance was reliable.[2] However, truck manufacturers claimed that existing antilock technology was unreliable and that these devices on the steering axle, in combination with strong front-wheel brakes, constituted a safety hazard. NHTSA asserted that problems with the antilock devices were caused by component variability and large compliance margins.

Subsequently, a lawsuit over Federal Motor Vehicle Safety Standard (FMVSS) 121 was brought by truck manufacturers and the American Trucking Associations against NHTSA, contending that no need had been demonstrated for the stopping distance standard, compliance was costly, and the standard's requirements were beyond the reach of current technology. Although the court found that NHTSA was justified in promulgating an air brake system standard, it invalidated the road test portions of FMVSS 121. This sequence of events had far-reaching effects on many aspects of vehicle design, performance, and operation, and has contributed to industry reluctance to implement antilock systems.

Despite recent advancements in antilock technology, revised brake standards have not yet been issued by NHTSA, although a new rulemaking effort was announced in 1979.[3] Before any formal regulatory action will be taken, NHTSA intends to complete both test-track and on-the-road evaluations of both European and American antilock brake systems.[4] Tests are scheduled to begin in fall 1988 and to be completed within 2 years.

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[1] Comments were initially requested in 1967. See 32 *Federal Register* 14279 (Oct. 14, 1967).

[2] See 36 *Federal Register* 3917 (1971), 37 *Federal Register* 12496 (1972), and 37 *Federal Register* 3907 (1972).

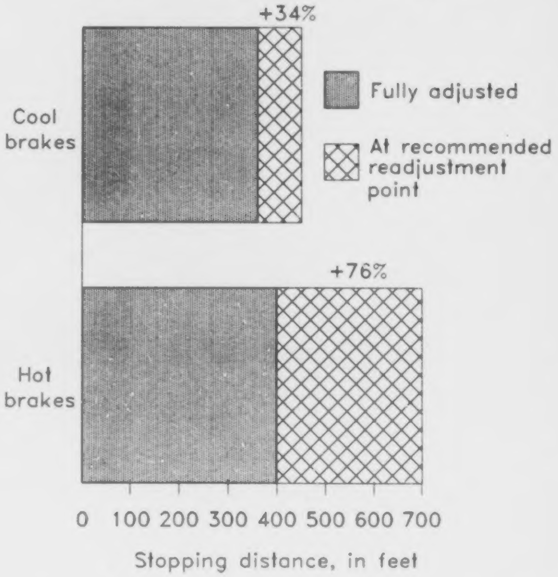
[3] 44 *Federal Register* 9783 (Feb. 15, 1979).

[4] Robert Clarke, National Highway Traffic Safety Administration, personal communication, Feb. 29, 1988.

drivers cannot sense brake adjustment when brake systems depends on compressed air for actuation.

Steering axle brakes are often poorly maintained—only half of trucks randomly inspected had operative front-wheel brakes. Those that were inoperative had missing parts or were so out of adjustment that the brakes did not function, and, in some cases, drivers had detached the front-wheel brakes.[43]

Figure 5-8.—Stopping Distance of Fully Loaded Truck at Two Brake Adjustment Levels



SOURCE: Office of Technology Assessment, 1988; based on National Highway Traffic Safety Administration data, 1987.

Most truck brakes must be adjusted manually, and this requires regular maintenance. However, automatic slack adjusters can take up the slack created by normal wear of the brake shoes. Although early models had problems with overadjustment, causing the brake to overheat and wear excessively, these problems have been overcome.[44] Approximately 20 percent of heavy vehicles are presently using automatic slack adjusters at a cost of $100-$150 per axle,[45] and three tractor manufacturers have announced plans to make these standard equipment within the next year.

Even poorly performing automatic adjusters, when properly installed, are improvements over manual brake adjustment. Their potential safety benefits underscore the need to establish a performance test and acceptable performance limits for brake adjustment systems. Such systems could be enhanced by diagnostic devices to indicate when routine brake adjustment maintenance is needed.

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[43] Studies by Cunagin (1986), Kirkpatrick (1986), and Smith (1986) as cited in National Highway Traffic Safety Administration, op. cit., footnote 18, p. 72.

[44] Jones, op. cit., footnote 31, p. 13.

[45] National Highway Traffic Safety Administration, op. cit., footnote 18, p. 74.

Brake Linings

Brake linings are essential components in providing sufficient braking force. Although Federal regulations specify minimum performance requirements for brakes on newly manufactured trucks, no standards exist for brake linings or replacement linings. In practice, heavy truck operators often do not or cannot obtain linings that match the performance of those that came as original equipment on the vehicle. This is due in part to the difficulty in identifying linings—lining codes are hard to read and interpret, and the code is destroyed as the lining wears out. Moreover brake linings vary widely from manufacturer to manufacturer, from formulation to formulation supplied by a single manufacturer, and even within a given formulation from batch to batch.[46]

Although equipment as fundamental as brake linings needs quality control and reliability, no immediate solution is available. The Society of Automotive Engineers is currently developing an improved method of rating brake linings, but the time to develop a rating scheme is lengthy, and the precision of the scheme is hard to predict.

Truck Steering and Handling

Heavy truck sizes and physical properties give them distinctly different and unique handling characteristics. Merging and turning actions, steering around corners, and lane changes present problems not found in car driving that increase the potential for truck accidents. Considerable research has been conducted on steering and handling as well as vehicle design and stability. The engineering details, as summarized below, have been well documented recently by NHTSA.[47]

Rollover

A rollover is a major risk in truck driving, especially for tractor-trailers. Truck rollovers occur because as a vehicle moves through a turn, centrifugal force acts to roll the vehicle outward from the turn, causing the vehicle's inside tires to lift from the ground. If the imbalance is too great, the vehicle rolls over. The ratio of the track width to the height of the truck's center of gravity is the basic determinant of the vehicle's stability, although in maneuvers such as lane changes, the dynamics of the vehicle are also important. For example, rollovers can also be caused by rearward amplification through the trailer, caused by inherent properties of the vehicle design. The most effective ways to reduce rollovers would be to lower the center of gravity and to use wider vehicles. Wider (102-inch) vehicles reduce loading heights and permit wider track and suspension spreads. It has been estimated that if both tractor and trailer were 102 inches wide, the incidence of rollovers might be reduced up to 35 percent for combination-unit trucks operating with medium-density freight.[48]

Rearward Amplification

Rearward amplification is manifested as rear trailer side-to-side oscillation. It can be caused by slight steering actions, by changes in road surface, or by wind disturbances. A driver's steering maneuver at the front of the vehicle increases in intensity at the rear of the vehicle or combination. Although the oscillations may not be large enough to cause loss of control, they sometimes result in trailing units encroaching on other traffic lanes and endangering other motorists, or moving off the pavement and striking a curb or roadside obstacle.

Rearward amplification greatly magnifies the effects of a steering action on the rear trailer of doubles units and LCVs. Furthermore, the driver of a multiple-trailer combination has difficulty avoiding a rollover caused by steering actions, because he cannot feel what the rear trailer is doing and because of the delays between steering inputs and responses at the end of the combination "train."[49] A driver's first indication of incipient rollover due to lateral oscillation of a trailer is observation of trailer motion via the rearview mirror,[50] although warning technologies have been developed.[51] Thus, trucking industry pressure to improve productivity and efficiency by using longer and multiple-trailer combination vehicles, makes rearward amplification and stability of rear trailers an issue of considerable concern.

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[46] Ibid, p. 77.

[47] Ibid., pp. 96-154.

[48] Ibid., p. 109.

[49] Ibid., p. 102.

[50] Roundtable discussion, *Proceedings, Symposium on Accommodation of Trucks on the Highway: Safety in Design*, op. cit., footnote 15.

[51] Edward Domenico, Truck Systems, Inc., personal communication, June 1, 1988.

Research has shown that rearward amplification is strongly related to the type of trailer-to-trailer hitching mechanism. The most common mechanism is currently the A-train, a dolly that is connected to the towing unit by a single pintle hitch (see figure 5-9). Although the A-train provides easy maneuverability at low speed, it is less stable at highway speed than a conventional tractor-semitrailer and has comparatively poor rearward amplification performance.

Technical solutions to rearward amplification are under consideration, although current alternatives all have trade-offs in cost, weight, maintenance, and operational difficulties compared with the A-dolly. The most basic innovation to the hitching mechanism has been the introduction of the B-train (see figure 5-9), which greatly reduces rearward amplification. In this design, the pintle hook articulation joint is eliminated and the vertical support and fifth wheel functions of the dolly are incorporated into the rear of the leading trailer. A number of practical problems limit the B-train's use to doubles where the trailers are always used together, are not interchangeable, and do not need to be unloaded from the rear.[52] Some Canadian provinces now give B-train users a 1,000-pound payload advantage.[53] A popular variation, the C-train, is composed of a tractor-semitrailer towing one or more full trailers made of a B-dolly and semitrailer.

Off-Tracking

Off-tracking occurs when the wheels on the rear axle of a vehicle do not follow the same track as the wheels on the front axle. (See the section on "Road Geometry" earlier in this chapter for a more detailed discussion). Off-tracking complicates heavy truck handling and steering for the driver during turning movements and on curved portions of roadways.

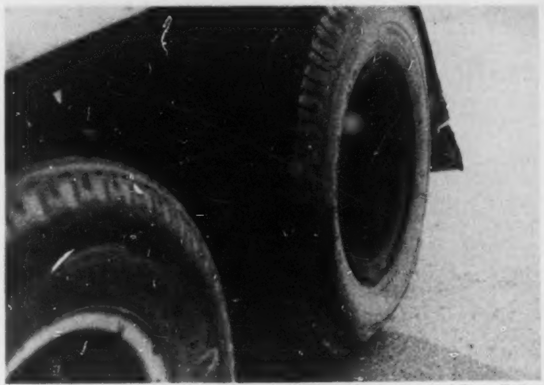

Photo credit: Michigan Department of State Police

Faulty tires and brakes are frequently cited as safety violations during inspections.

Truck Tires

Tire performance affects the stability and control of trucks. Ultimately, tires transmit all the driving and braking torque, and develop the cornering and directional stability essential to the performance of highway vehicles. Tire manufacturing technology has advanced considerably in the past 10 to 15 years, so that fewer than 5 percent of tire failures are believed to be due to manufacturing or material failures. Accident reconstructions suggest that a tire failure in an accident is more likely to occur than an accident caused by a tire failure.[54] Although metal objects, debris in the roadway, and poor tire maintenance (principally underinflation) are major causes of tire failure, little is known about tire failures that cause accidents.[55]

Radial tires have become the standard of the industry although bias-ply tires are used as well. Lifecycle cost analyses have determined that radial tires have longer tread wear, more durable casings, yield greater fuel economy due to lower rolling resistance, and provide better handling. These advantages far outweigh the higher initial costs.[56]

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[52] National Highway Traffic Safety Administration, op. cit., footnote 18, p. 130.

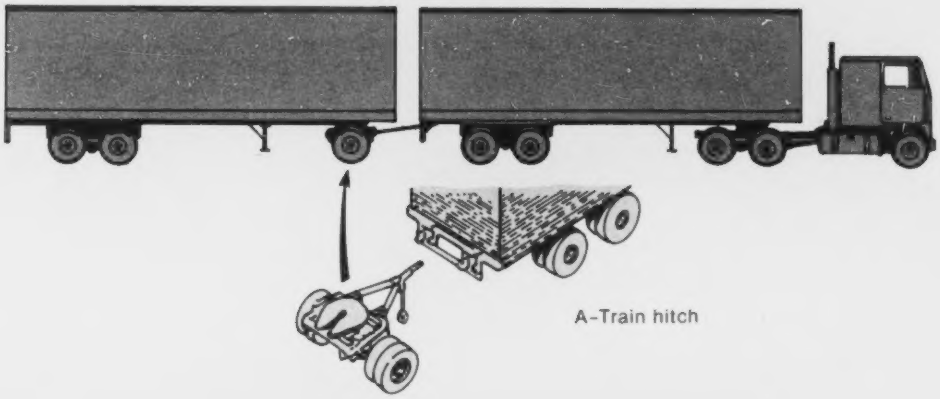
[53] Ian Jones, Insurance Institute for Highway Safety, personal communication, Apr. 19, 1988.

[54] David Williams, Smithers Scientific Services, personal communication, May 17, 1988.

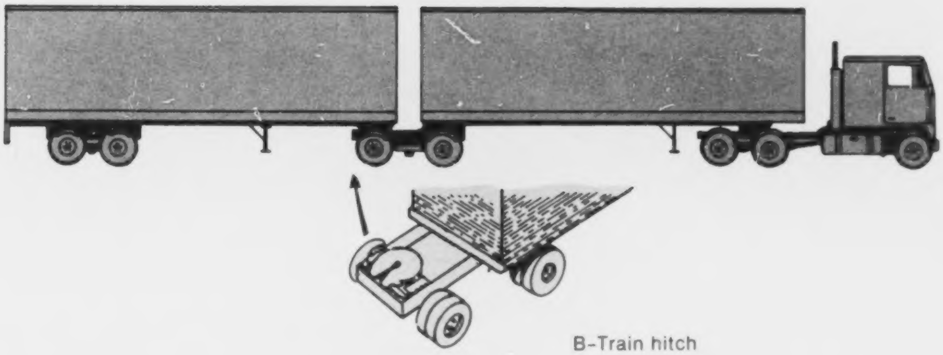
[55] Peggy Fisher, president, Roadway Tire Co., personal communication, May 17, 1988.

[56] Thomas Ford and Joseph Zekoski, "Impact of Truck Tire Selection on Contact Pressures," presented at the Paving and Transportation Conference, Symposium on Pavement Rutting, University of New Mexico, Jan. 4, 1988.

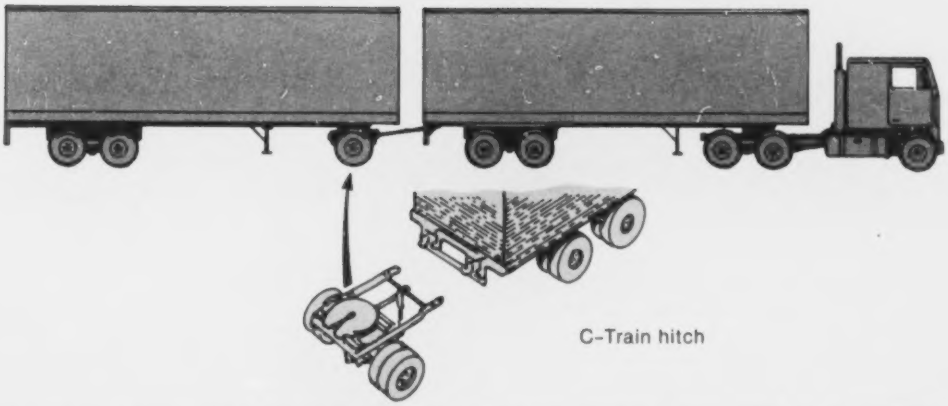
Figure 5-9.—Hitching Mechanisms for Twin-Trailer Trucks



A-Train hitch



B-Train hitch



C-Train hitch

SOURCE: Roads and Transportation Association of Canada, "Canadian Vehicle Weights and Dimensions Study," Technical Steering Committee Report, 1987.

Retread tires are used throughout the industry, although no studies have been completed of the extent of their use or their impact on safety. The retread industry has made considerable advances in product reliability in recent years, due to demands from both the trucking and airline industries, and confidence in the product is high.[57] Trucking firms with successful maintenance programs have found retreading to be safe and cost-effective, and some even find it advantageous to do their own retreading.[58]

An industry trend is visible toward use of low profile tires for line-haul trucking.[59] These have a shorter side wall than standard tires, permitting lower trailer floors and greater trailer capacity. Coupled with improved wheel systems, low profile tires can reduce truck weight, maintenance costs, and recapping costs.[60]

Using a single, wider tire to replace a pair of standard tires to reduce both capital and operating costs is also being considered by industry. Safety concerns include the fact that single tires on trucks running empty have less lateral grip, and the tires can bounce sideways. Moreover, heavily loaded single tires do not spread the loaded weight in the same manner as dual tires and may cause additional damage to the road pavement and the roadbed.[61]

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[57] Fisher, op. cit., footnote 55.

[58] Gerald F. Stanley, "The Master of Maintenance," *Commercial Carrier Journal*, May 1988, pp. 73-78.

[59] Ford and Zekoski, op. cit., footnote 56, p. 10.

[60] *Overdrive*, "As the Wheel Turns," September 1987, pp. 14-18.

[61] Asa Sharp, Goodyear Tire Co., personal communication, May 6, 1988.

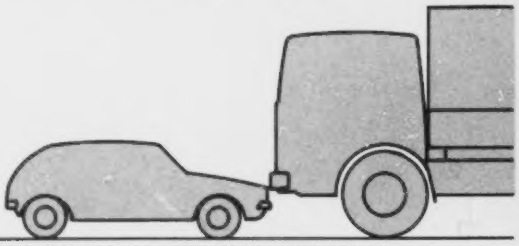
TRUCKS AND OTHER TRAFFIC

Collisions between heavy trucks and smaller vehicles, primarily cars, inevitably result in more serious consequences to the occupants of the smaller vehicle. A truck can weigh as much as 40 times more than a car, has a much stiffer structure, and stands higher above the ground. Trucks are designed to carry heavy payloads and have large, stiff frames that do not generally deform much in a frontal collision and therefore absorb little of the kinetic energy generated in a crash. Thus, when cars and trucks collide, practically all of the damage occurs to the car.[62]

Override and Underride

In a car/truck collision, if the truck's bumper or body structure is too high to engage the car's bumper, the car's primary energy absorption capability is not utilized (see figure 5-10). Either the car strikes the truck and slides underneath it (underride), or the truck strikes the car and climbs over it (override).[63]

Figure 5-10.—Typical Car/Truck Front Bumper Height Differential



SOURCE: National Highway Traffic Safety Administration.

Rear-end collisions in which passenger vehicles underride the rear ends of trucks or trailers are very likely to cause fatalities. A study of fatal accidents in Texas and Michigan found that underride occurs in more than 90 percent of car/truck rear-end collisions.[64] NHTSA estimates that truck underride accidents account for approximately 300 occupant fatalities per year, or 1 percent of all fatalities.[65]

A Federal standard requiring an underride guard on trucks and trailers in excess of 10,000 pounds was originally proposed by NHTSA in 1969. NHTSA subsequently amended its proposal by requiring

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[62] National Highway Traffic Safety Administration, op. cit., footnote 18, p. 138.

[63] Ibid., p. 145.

[64] Insurance Institute for Highway Safety, op. cit., footnote 32, p. 7.

[65] Jeffrey Miller, deputy administrator, National Highway Traffic Safety Administration, testimony before the House Committee on Appropriations, Subcommittee on Transportation and Related Agencies, March 1986, p. 73.

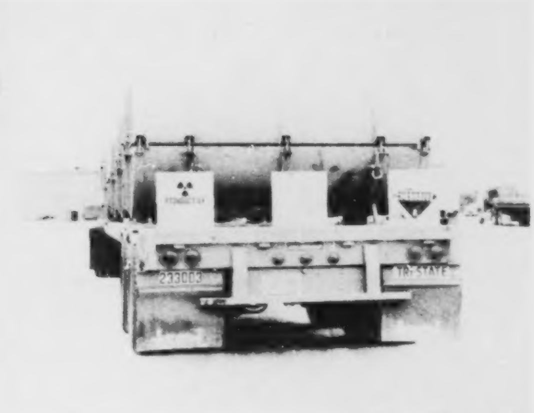

Photo credit: Land Line

Sturdy rear underride guards can prevent a car from sliding under the truck—a frequent cause of fatalities in such accidents.

trucks and trailers to meet a modified strength test with whatever components were in position to contact the test block.[66] However, NHTSA has never issued a final standard. Underride guards for the rear ends of trucks are required by FHWA under Federal Motor Carrier Safety Regulation 393.86, although many safety experts believe the standards specify guards that are not strong or low enough. In the absence of an adequate Federal standard, the Michigan legislature established a standard similar to the modified NHTSA proposal and required rear underride guards for 53-foot trailers in 1986.[67]

NHTSA officials recently stated that alternatives, such as visibility enhancements for the sides and rear ends of trucks, are being tested.[68] These include additional lighting and reflective materials that would help drivers avoid collisions altogether.

Researchers in Germany have sought to design truck front-end protection to reduce override impact. The most effective design was found to be an energy-absorbing bumper mounted low; it absorbed energy, and disengaged and deflected the car after initial impact.[69] Independent tests conducted in Britain showed that a device with certain force and deflection characteristics fitted to the front of trucks, could substantially reduce override and injuries and fatalities.[70]

Splash and Spray Protection

Splash and spray created by a heavy truck on a wet pavement restricts the view for both car and truck drivers. Section 404 of the STAA directed DOT to establish minimum standards for the performance and installation of splash and spray suppression devices for use on truck tractors, semitrailers, and trailers to improve visibility on wet roadways.[71] The statute required the development of these standards within a year. In 1984, Congress extended the industry compliance deadlines in the 1982 act, because standards had not yet been issued by FHWA and NHTSA.[72]

In 1985, NHTSA published a notice of proposed rulemaking requesting comments on minimum standards and installation requirements for spray suppressant flaps and side skirts.[73] The proposal

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[66] The proposed test block was a rectangle 4-inches high and 12-inches wide, and its height was uniformly set with the lower edge 16 inches from the ground. Each truck or trailer had to meet the strength test at all points out to the outermost test points on the vehicle. These changes were made in response to industry concerns about economic and operational difficulties posed by a requirement for a maximum road clearance of 18 inches. 35 *Federal Register* 12956 (Aug. 14, 1970).

[67] Robert Ervin, University of Michigan, in U.S. Congress, Office of Technology Assessment, "Transcript of Proceedings—OTA Workshop on Technologies Affecting Truck Safety," unpublished transcript, Mar. 10, 1987, p. 210.

[68] Miller, op. cit., footnote 65; and Diane Steed, administrator, National Highway Traffic Safety Administration, testimony before the House Committee on Appropriations, Subcommittee on Transportation and Related Agencies, March 1986, p. 73.

[69] M. Danner and K. Langwieder, Association of German Automotive Insurers, Department of Automotive Engineering, "Results of an Analysis of Truck Accidents and Possibilities of Reducing Their Consequences Discussed on the Basis of Car-to-Truck Crash Tests," Paper No. 811027, unpublished manuscript, 1984.

[70] S. Penoyre and B. Riley, Transport and Road Research Laboratory, "Desirable Structural Features for the Design of Front and Rear Underrun Bumpers for Heavy Goods Vehicles," Report No. C168/84, unpublished manuscript, 1984.

[71] Section 414 of the Surface Transportation Assistance Act of 1982, Public Law 97-424, 49 U.S.C. 2314. In 1970, the National Highway Traffic Safety Administration issued a notice of proposed rulemaking that would have required spray protectors on most heavy trucks; these devices consisted of fenders, modified side skirts, and mudflaps. However, subsequent tests indicated that use of this equipment caused a dangerous level of brake heat buildup. The National Highway Traffic Safety Administration withdrew the proposal in 1973. See 35 *Federal Register* 14091 (Sept. 4, 1970) and 38 *Federal Register* 28840 (Oct. 17, 1973).

[72] Section 223 of the Motor Carrier Safety Act of 1984, Public Law 98-554, 98 Stat. 2847. New trucks were to have been required to comply with splash and spray suppressant standards within 1 year after they are promulgated. Existing trucks were to be retrofitted within 4 years after the standards were issued.

[73] 50 *Federal Register* 14631 (Apr. 12, 1985). Spray suppressant flaps hang down behind tires and are designed to reduce the amount of spray. Side skirts are flat surfaces that hang down from the side of a vehicle

(continued on next page)

suggested that flaps capable of varying levels of spray reduction would be required.[74] FHWA also published a proposed rule, consistent with NHTSA requirements, requiring the installation of flaps and side skirts on truck tractors and certain semitrailers manufactured on or after 1 year from the effective date of a final rule. Older vehicles would be retrofitted within 4 years.[75] The motor carrier industry reacted negatively to the proposed rulemakings, and in late spring 1988, NHTSA formally dropped all proposed requirements for spray reducing materials on heavy trucks.

While recent research generally shows that these devices decrease the density of the spray cloud, test results vary according to the type of vehicle used and other environmental conditions.[76] For example, drop-frame trailers, such as those used by United Parcel Service (UPS) and some household goods moving companies, do not have much distance between trailer and road surface, and the wheel well creates a compact area where the water is contained.[77] Nevertheless, UPS is using effective splash and spray retarding equipment on tractor-trailer combinations. The cost per unit is in excess of $200 ($30 for tractor hardware, $25 for the dolly, $120 for side skirt mounting, $5 per flap, and $40 to install the splash suppressant bristles on the side of the trailer). UPS believes that it provides a safer environment for motorists and improves the public's perception of the trucker.

However, maintenance problems are associated with some splash and spray guards. Rubber flaps tend to break off. Ice builds up on the flap face and eventually falls onto the roadway in chunks, creating a different safety hazard. On some vehicle configurations, such as tankers, dump trucks, and loggers, plastic bristles do not stay on the flaps of the truck for very long. Perhaps the most pressing application is for splash and spray controls on longer combination vehicles and triple-trailer combinations, where water is thrown out by additional axles and wheels. Oregon has a regulation that requires all triples to install splash and spray equipment. Tests of aerodynamically-shaped tractors and trailers show that properly designed side deflectors and dams on tractors and skirts on trailers can substantially reduce splash and spray.[78]

Open-graded asphalt used in road construction can also decrease splash and spray, give good traction in wet weather, and reduce road noise dramatically. The effective lifetime of this material is around 5 years, yet the cost of laying down the pavement is relatively modest.

Truck Visibility

Automobile drivers have a difficult time at night correctly perceiving the shape, road position, location, and speed of poorly illuminated trailers. This problem makes rear and/or side underride accidents even more likely. A NHTSA test using relatively inexpensive reflective markings for the rear ends of trailers showed that the markings significantly reduced rear and side collisions at night. It is estimated that $50 to $100 worth of reflective tape (purchase and installation per trailer) could produce a 15-percent accident reduction.[79]

Photo credit: Freightliner Corp.

Aerodynamic side deflectors and dams are attached to this cab to increase fuel efficiency and reduce splash and spray.

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and prevent water coming off the top wheel wells, tires, and vehicles bottom from forming into spray clouds.

[74] The National Highway Traffic Safety Administration also stated that when flaps capable of achieving a 75-percent reduction in spray became available (anticipated within 4 years), new vehicles would be required to have the improved flaps.

[75] 50 *Federal Register* 14630 (Apr. 12, 1985).

[76] Miller, op. cit. footnote 65; and Neil Thomas, Office of Motor Carriers, Standards Development Division, personal communication, Mar. 25, 1987.

[77] Thomas Hardeman, United Parcel Service, in Office of Technology Assessment, op. cit., footnote 67, p. 161.

[78] Farrel Krall, Navistar International Corp., personal communication, Aug. 5, 1988.

[79] William J. Burger et al., *Improved Commercial Vehicle Conspicuity and Signalling Systems: Task 3, Field Test Evaluation of Ve-*

(continued on next page)

Industry has taken its own initiatives in this area as part of corporate marketing. For example, Frito-Lay places a reflective company logo on the rear door of each trailer. However, this can present a separate hazard if other drivers mistake a vehicle for a fixed facility on the side of a roadway. A performance standard that improves luminosity without restricting corporate graphics is likely to gain industry acceptance.

Poorly illuminated trailers can also increase risk of side underride collisions. For example, a trailer being maneuvered into position at a loading dock of an older urban plant or warehouse may briefly block the travel lanes of a busy city street. Without special measures to increase its visibility at night, the trailer may not be reflected soon enough for the car driver to react. Flatbed trailers pose special problems because their lack of exterior surfaces does not provide sufficient area for extensive safety-lighting fixtures.

Color also plays a role in truck visibility at night. It can assist another vehicle driver in determining the speed of an approaching truck. The color green is used in Japan on trucks weighing over 17,600 pounds. A series of green vehicle marker lights signal the speed of a truck; one light indicates the truck engine is running; two lights mean the truck is going more than 25 mph; and three lights indicate the truck speed to be 38 mph or greater.[80] Colors also cause bias in depth perception, an important factor for drivers of vehicles moving at different speeds at night. For example, the color red is seen before the color blue on a distant object,[81] and the arrangement of lights can also provide cues about an object's proximity and its relative speed.[82] Moreover, one's reaction to lights and colors is somewhat dependent on knowing what one is looking at.[83]

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hicle Reflectionization Effectiveness (Washington, DC: National Highway Traffic Safety Administration, September 1985), p. III-8 per errata sheet.

[80] Jim Winsor, "Japanese Trucking: Tougher Equipment Safety Regs," *Heavy Duty Trucking*, December 1987, p. 16.

[81] Louis Siverstern, research section chief, Systems and Research Center, Honeywell, Inc., personal communication, Apr. 27, 1988.

[82] Rudolf Mortimer, professor, Department of Health and Safety Studies, University of Illinois, Urbana, personal communication, Apr. 27, 1988.

[83] Ibid.

MOTOR CARRIER DRIVER SAFETY

Although much of the attention to truck safety has focused on the impact of truck safety on other vehicle occupants, the safety of a truck driver is also of concern. Ejection is one of the leading causes of fatalities and injuries among tractor-trailer occupants, and all available data indicate drivers sustain proportionately more serious injuries if they are thrown from the vehicle.[84] The simplest way to prevent ejections is through use of safety belts, and a driver that remains seated has a chance to regain control of the vehicle after an accident. Nevertheless, reluctance to use a safety belt remains a major problem among truck drivers. Efforts have been under way since 1980 to encourage more drivers to wear safety belts, and industry groups have assisted motor carriers with programs to convince cab occupants to wear safety belts. Current designs, however, are based upon passenger car standards and are not necessarily appropriately designed for truck installation.[85]

Truck Cab Structure

Strengthening the structure of truck cabs could make them more crush resistant and better able to protect occupants. However, many serious injuries sustained by truck occupants who remain inside the vehicle during accidents result from contact with interior components, primarily the steering wheel. Research on cab interiors has focused on materials, fire resistance, noise absorption, and projectile reduction.

Since the majority of crash-involved truck drivers move in more than one direction during the crash sequence, contacts with the steering wheel, windshield, instrument panel, and surfaces of doors and door headers are common sources of injury.[86] At least one European truck manufacturer uses a steering wheel that is both smaller and more flexible than those typically installed in U.S. trucks. Limited case study evidence has shown that this design causes fewer and less severe driver injuries in crashes.[87] Research in this area has lagged in the United States.

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[84] National Highway Traffic Safety Administration, *Truck Occupant Protection*, prepared in response to the Motor Carrier Safety Act of 1984 (Washington, DC: U.S. Department of Transportation, December 1986).

[85] Robert E. Heglund, assistant vice president and manager, Transportation Services Loss Prevention Department, Liberty Mutual Insurance Group, personal communication, Mar. 22, 1988.

Post-Crash Fires

In most cases, it is extremely difficult to pinpoint the exact source of truck fires, especially when more than one vehicle is involved in the crash. Fuel from the truck is apparently a primary factor. Improvements to address this issue focus on the concept of "cab fireworthiness." Suggestions have been made to incorporate on-board automatic fire suppression equipment; "kill switches" for electrical systems to eliminate ignition sources; use of flame-resistant, nontoxic materials in the cab; and methods and devices to protect cab occupants during a cab-engulfing fire for a limited time period. At least one truck manufacturer currently locates the batteries under the cab, to try to reduce the likelihood of fire after a collision.

Cab Environment

The immediate working environment for the truck driver is the truck cab. Equipment manufacturers and the trucking industry have examined seats, safety belts, controls, access, and noise to determine the best design for actual driver's use.[88] A properly designed truck cab can ". . . increase the productivity of drivers of heavy trucks by reducing driver fatigue, improving driver satisfaction and morale, and reducing the number of accidents."[89]

The ambient environment within the truck cab also has an effect on the driver. Tests have shown that contamination from diesel vehicle carbon monoxide is not a problem, but that nitrous oxide levels can be higher than recommended by the National Institute for Occupational Safety and Health.[90]

Photo credit: Michael Hines, OTA staff

Heat, noise, and vibration in the truck cab contribute to a stressful working environment for drivers.

Ride quality in heavy trucks is sometimes very poor. This complex issue is a product of variations in the truck design including wheel base, axle location, frame stiffness, and suspension type as well as vehicle load and road surface condition. The large engine in close proximity to the cab adds vibration, noise, and heat. Heat and humidity have an adverse effect on driver physiology and performance, noise levels are often high enough to have adverse effects, and vibrations are at a level that creates fatigue.[91] These pose formidable challenges for researchers and manufacturers.

On-Board Recording Devices

On-board devices that record engine revolutions per minute, vehicle speed, oil temperature and pressure, cooling system temperature, and so forth are currently available for approximately $1,500 to $2,500. Although the information collected permits the examination of distance traveled, driving time, breaks, daily rest periods, and speed limit compliance, carriers usually purchase these systems to manage fuel efficiency. Safety advocates have proposed using on-board recording devices to improve compliance with hours-of-service rules and speed limits.

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[86] National Highway Traffic Safety Administration, op. cit., footnote 84, p. 76.

[87] Ibid., p. 78.

[88] Mark Sanders, "U.S. Truck Driver Anthropometric and Truck Work Space Data Survey," prepared for the Society of Automotive Engineers, January 1983.

[89] Thage Berggren, "Equipment Productivity: At What Price?" unpublished remarks to the American Trucking Associations Foundation Meeting, Ocean Reef, FL, Apr. 29, 1988.

[90] Federal Highway Administration, *Toxic Gases in Heavy Duty Diesel Truck Cabs*, Report No. FHWA-RD-77-139 (Washington, DC: U.S. Department of Transportation, October 1977).

[91] National Highway Traffic Safety Administration, *A Study of Heat, Noise, and Vibration in Relation to Driver Performance and Physiological Status*, Report No. HS-801313 (Washington, DC: U.S. Department of Transportation, December 1974).

One firm reports that an on-board device pays for itself in 6 months through cost savings in fuel, maintenance, and driver time (reduced paperwork requirements).[92] It also helps streamline the preparation of reports that must be kept on file by the company for oversight agencies,[93] providing an economic incentive for installing the device. The system also includes an alarm that is activated if a driver operates at speeds greater than 55 mph for more than 1 minute, a capability that made the company decide installation of speed governors was unnecessary. Management made major efforts to gain acceptance from drivers before installing the devices, giving seminars to help drivers understand how and why the organization was going to use the recorders. After initial resistance, drivers understood that the recorders could be advantageous, proving, for example, that a late delivery stemmed from following the rules.[94]

Another large transport company reported that since it installed on-board recording devices, fuel mileage has improved by 12 percent, tire mileage has increased to 270,000 miles, brake lining life has increased, and insurance rates have dropped. To gain acceptance among drivers, the company initiated an incentive plan based on the driver's performance evaluation. From information gathered by the recording device, each driver receives a grade based on a cumulative average of all major functions on the trip, such as maximum speed, engine revolutions, and idle time. The incentive plan pays drivers an extra 2 cents a mile if they receive a performance grade of 10, and 1 cent per mile for a grade of 9. Some drivers now prefer trucks equipped with the devices so that they can earn extra compensation.[95]

An insurance case was recently settled on the basis that the tape from an on-board recording device showed that a truck driver had geared down in anticipation of an automobile driver's cutting in front of him to enter a ramp. The device showed that the truck driver did, in fact, gear down, but could not do so fast enough to prevent the accident. The automobile driver lost the case.[96]

While several European countries currently require on-board recording devices in their heavy trucks, installation of these devices on trucks in the United States remains voluntary, although their use is increasing.[97] Companies using on-board recorders as standard fleet equipment are doing so for multiple management-related reasons, not primarily to improve the fleet safety record.[98] Although some devices may not be tamper proof, FHWA has determined that tampering with on-board computers is not a serious problem.[99]

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[92] Phillip Brown, The Travelers Companies, in Office of Technology Assessment, op. cit., footnote 67, p. 183.

[93] The Department of Transportation has accepted recording device output in lieu of logbooks for some carriers.

[94] Phillip Brown, The Travelers Companies, in Office of Technology Assessment, op. cit., footnote 67, p. 186.

[95] *Private Line*, "A Driver Incentive Plan, With an On-Board Computer, Rewards Proper Vehicle Operation," October 1986, p. 15.

[96] Phillip Brown, The Travelers Companies, in Office of Technology Assessment, op. cit., footnote 67, pp. 236-237.

[97] Freightliner estimates that about 5 percent of their new trucks are equipped with electronic recorders at the customer's request (Otto Carroll, Freightliner, personal communication, Aug. 3, 1988). Rockwell estimates that on-board electronic recording systems are currently being used on about 1 percent of the heavy trucks in operation. G.J. Flannery, Rockwell International, personal communication, Feb. 25, 1987.

[98] Victor Jennings, Ryder Truck Rental, in Office of Technology Assessment, op. cit., footnote 67, pp. 185-186.

[99] Notice of Proposed Rulemaking, Federal Highway Administration, Mar. 13, 1988.

CONCLUSIONS AND POLICY OPTIONS

Highway system design issues and heavy vehicle safety technologies interact as parts of a system. Yet, too frequently, components of the system are treated as isolated and separate by government agencies and the respective industries. While some technical improvements for heavy vehicles are under development, major safety issues remain unaddressed. Changes to government policies allowing larger truck sizes and heavier weights have occurred far faster than changes to highway design standards. **OTA finds that Congress may wish to require DOT to develop a systematic Federal approach to motor carrier safety. A first step is better coordination on heavy vehicle and highway safety issues among DOT agencies, including NHTSA and FHWA's Office of Motor Carriers (OMC), high-**

way planning, safety, and design offices. Key components include accumulation of objective data to identify highway design problems and aggressive testing programs to determine the point at which equipment technologies and accident countermeasures are reliable and cost-effective. Also important are consistent Federal regulations, long-overdue at DOT—NHTSA and OMC brake standards still differ in some respects.

Furthermore, OTA finds that resolving conflicts, such as industry's push for still longer vehicles and the limitations of the Nation's road network, will require far better communication and cooperation by Federal and State governments and industry. State decisions on permissible vehicle sizes and weights are often not consistent with the ability of the highway system to accommodate the vehicles. Working groups that can focus on setting research agendas and model standards, developing interim countermeasures, voluntary field testing by industry, and the sharing of experimental data can contribute. No governmental mechanism exists currently that adequately deals with such difficult issues, and active participation by Federal and State officials is essential to a systems approach.

While the stability and braking characteristics of heavy trucks have been well studied by NHTSA, cab occupant protection and reducing the effects of car/truck collisions are two areas that need additional research. **Congress may wish to encourage NHTSA to step up work on these important safety technology issues with the goal of determining and implementing appropriate standards.**

The Federal Government has a role to play in determining whether safety technologies should be specified as *performance criteria* (which state minimum acceptable capabilities) or as mandated *design standards* (which specify in detail the equipment that must be used).[100]

Vehicle equipment compatibility issues are extremely difficult for industry to resolve without active Federal participation. **OTA concludes that Federal agencies such as OMC, NHTSA, and industry must jointly seek solutions to compatibility issues.**[101] While truck manufacturers and users agree that upgraded Federal brake standards are needed, they also stress that industry should work with NHTSA and FHWA to test new technologies and to develop appropriate regulations.

OTA finds that issuing standards for antilock brakes will be warranted within the next 3 to 5 years. The NHTSA test program for antilock brakes on tractors now underway is an essential step. Antilock systems for tractors and trailers is the ultimate goal. If manufacturers of both tractors and trailers are involved in the rulemaking process, the development and acceptance of compatible and well-balanced braking systems will be accelerated.[102] The Tractor Trailer Brake Research Group, an industry group (see figure 5-11), has been working very slowly toward resolving longstanding brake and compatibility issues. Active participation by NHTSA and OMC could speed the process. **OTA concludes that the Federal Government could play an active role in brake lining performance tests and identification methodology, with the goal of issuing performance criteria and compatibility standards for both original and replacement linings.** Other longer-range brake research activities also warrant Federal support. Examples of basic research include "braking by wire" and improving tire/braking force capability.

Critical needs exist for maintaining existing technologies even while new innovations are under consideration—initiatives for improving brake maintenance, for example. Widespread misunderstanding of truck brake systems and brake maintenance and adjustment suggests a need for a comprehensive education program for owners and operators of all fleets and mechanics. A training requirement for mechanics could be an important step.

Manufacturers indicate that enough is known about vehicle visibility and splash and spray for preliminary equipment standards and performance criteria to be developed. NHTSA may have overlooked some possible splash and spray control options. Congress may wish to request NHTSA to address these issues with renewed vigor and issue regulations in the near future.

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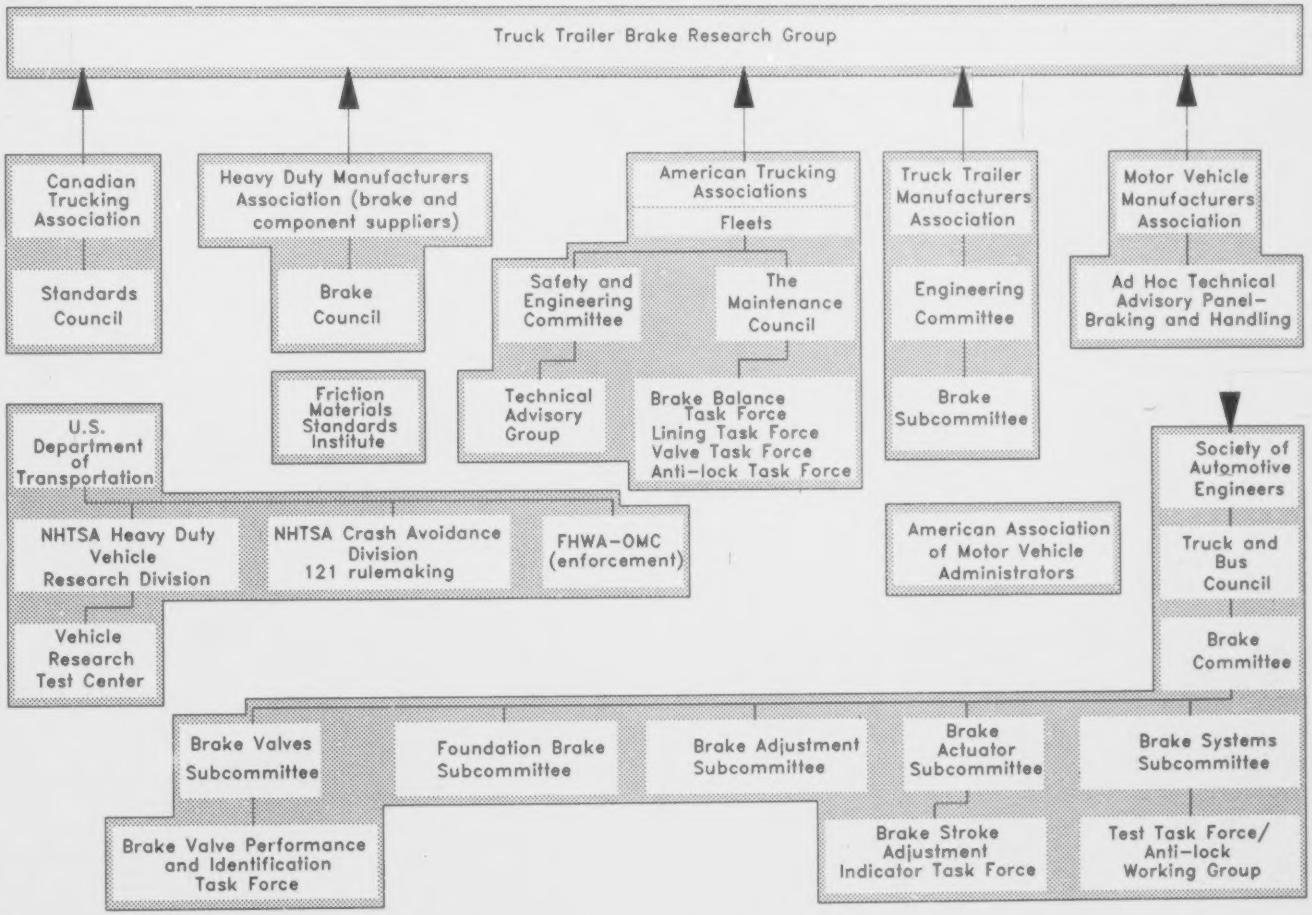
[100] Joe R. Morris, "Safety Implications of Changes in Truck Size and Weight Limits," *Proceedings of Organisation for Economic Cooperation and Development Symposium on the Role of Heavy Freight Vehicles in Traffic* (Ottawa, Canada: Organisation for Economic Cooperation and Development, Apr. 27-30, 1987), vol. 3, pp. 4-14.

[101] Office of Technology Assessment, op. cit., footnote 67.

[102] Ibid., pp. 32-43.

Figure 5-11.—Organizations Involved in Brake Matters


Truck Trailer Brake Research Group
Canadian Trucking Association
Standards Council
Heavy Duty Manufacturers Association (brake and component suppliers)
Brake Council
Friction Materials Standards Institute
American Trucking Associations
Fleets
Safety and Engineering Committee
The Maintenance Council
Technical Advisory Group
Brake Balance Task Force
Lining Task Force
Valve Task Force
Anti-lock Task Force
Truck Trailer Manufacturers Association
Engineering Committee
Brake Subcommittee
Motor Vehicle Manufacturers Association
Ad Hoc Technical Advisory Panel—Braking and Handling
U.S. Department of Transportation
NHTSA Heavy Duty Vehicle Research Division
NHTSA Crash Avoidance Division 121 rulemaking
FHWA-OMC (enforcement)
Vehicle Research Test Center
American Association of Motor Vehicle Administrators
Society of Automotive Engineers
Truck and Bus Council
Brake Committee
Brake Valves Subcommittee
Foundation Brake Subcommittee
Brake Adjustment Subcommittee
Brake Actuator Subcommittee
Brake Systems Subcommittee
Brake Valve Performance and Identification Task Force
Brake Stroke Adjustment Indicator Task Force
Test Task Force/ Anti-lock Working Group

KEY: NHTSA = National Highway Transportation Safety Administration;
FHWA = Federal Highway Administration; OMC = Office of Motor Carriers

SOURCE: Office of Technology Assessment, based on information from American Trucking Associations, 1987.

The adoption of safety-related technologies by trucking firms and owner-operators is not an automatic process. The technologies must mitigate a perceived or apparent problem and provide a reasonably short-term return on investment. Because they do not have economies of scale available to large firms, owner-operators have difficulty realizing economic payback for safety-related equipment. Improved safety equipment that has clear economic benefit will eventually be accepted by industry,[103] as evidenced by purchases of technologies such as automatic slack adjusters.[104] **OTA finds that when economic advantages of equipment that has proven safety value are not apparent, setting minimum Federal standards for equipment that apply equally to all motor carriers, regardless of classification, is appropriate.**

Since many equipment safety issues do not translate directly into improved productivity, industry acceptance of new technologies is slow under any circumstances. The fragmentation of the industry hampers dissemination of safety information on new technologies. **OTA finds that a thorough education and information program for new technology requirements could benefit purchasers and users. Congress may wish to allocate resources for such tasks.** Video instructional displays at truck stops around the country could inform drivers of the risks they take by operating trucks with deficient brakes, tires, or lights. These displays could also present information on ways to avoid and correct other safety problems. States could coordinate these activities with their enforcement programs.

Retrofitting trucks with newly mandated safety equipment can have significant costs. Difficulty in designing retrofit equipment adaptable to all older vehicles and the evolutionary nature of technology focus manufacturers' R&D efforts toward new vehicles.[105] **Congress may wish to consider requiring DOT to develop implementation programs for new and retrofit technologies, and to set deadlines for programs.**

Finally, the cost of educating drivers to use new safety equipment is one that will have to be accounted for in the marketplace. **Although carriers may need to pay drivers and mechanics more for having additional technical skills, the higher costs to shippers and ultimately the public can be more than offset by reduced accident costs.**

On-board recording devices are cost-effective management tools and can motivate drivers to be more efficient. Their use for driver oversight has also been successful if management followup is appropriate. However, management experience to date shows that careful dialog with drivers to minimize potential adverse reactions is important when introducing the devices. **OTA finds that an immediate mandatory requirement for on-board recording devices may be premature.** Education for management, labor, and enforcement officers is essential to promote acceptance of these tools as safety devices and prevent abuse. **Congress may wish to consider requiring DOT to plan and implement a program to accomplish these goals.**

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[103] Ibid.

[104] William Leasure, National Highway Traffic Safety Administration, in Office of Technology Assessment, op. cit., footnote 67, p. 170.

[105] P.A. Gustafson, Cummins Engine Co., Inc., personal communication, Apr. 28, 1987.

Chapter 6

Human Factors in Truck Safety

Photo credit: Karen Mathiasen, OTA staff

Trainees watch an instructor demonstrate how to back up a truck.

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Chapter 6

Human Factors in Truck Safety

Heavy vehicle drivers must continuously process and react to a variety of information, and even momentary lapses in concentration can cause an accident. The behavior of other drivers, the vehicle, roadway design, and the traffic environment all can distract the driver, as can other factors such as carrier management attitudes and policies or economic and scheduling pressures. Human error is cited as the cause of over 60 percent of motor carrier accidents.

Although the Federal Government has focused on some aspects of vehicle and highway design, it has given inadequate attention to the interacting and subtle human factors that affect motor carrier safety. This chapter describes driver performance and explores the relationship between human factors and truck safety, describing industry safety programs and identifying Federal policy options.

THE DRIVER

The typical human information processing sequence includes receiving information, recognizing and evaluating it, reaching a decision, and taking action—all within a very short time period. (See figure 6-1.) An alert driver can process information in less than 2 seconds when confronted with an unexpected hazard in the roadway.[1] However, fatigue or other impairment affects both the speed of the driver's mental processes and the accuracy of his judgment.[2] The continual changes in the roadway environment and the special skills required in stopping and maneuvering heavy trucks suggest that a competent heavy truck driver should be well trained, experienced, and alert.

Driver Screening

Driving a heavy vehicle demands greater skills than operating a passenger car, both in normal driving situations and in responding to potential hazards.[3] Heavy trucks are less easily maneuvered than automobiles, requiring greater distances for passing, stopping, turning, and accelerating, and forcing drivers to anticipate and avoid potential traffic conflicts. Thus, a safety conscious carrier manager will take seriously the task of identifying and hiring drivers with appropriate skills, attitudes, and training.

U.S. Department of Transportation (DOT) requirements for carrier hiring procedures are broad enough to permit wide variations in company practices. All driver applicants must complete a written application and must take a road test and a written test. However DOT gives no clear guidelines for what constitutes "passing" either test. In fact, DOT does not require that the knowledge test be passed, only that the applicant be told the correct answer for the items missed. (For further details on requirements, see chapter 3.) In practice, even these regulations are ignored by some carriers or interpreted with considerable latitude. Commercial Driver's License Program[4] tests will determine whether a prospective driver has the minimal level of skills to operate a heavy truck. However, the carrier management's evaluation of a driver's background and skills will remain the dominant hiring standard.

Many carriers devote careful attention to driver hiring, requiring reference checks, referrals, drug screening, and interviews, over and above the back-

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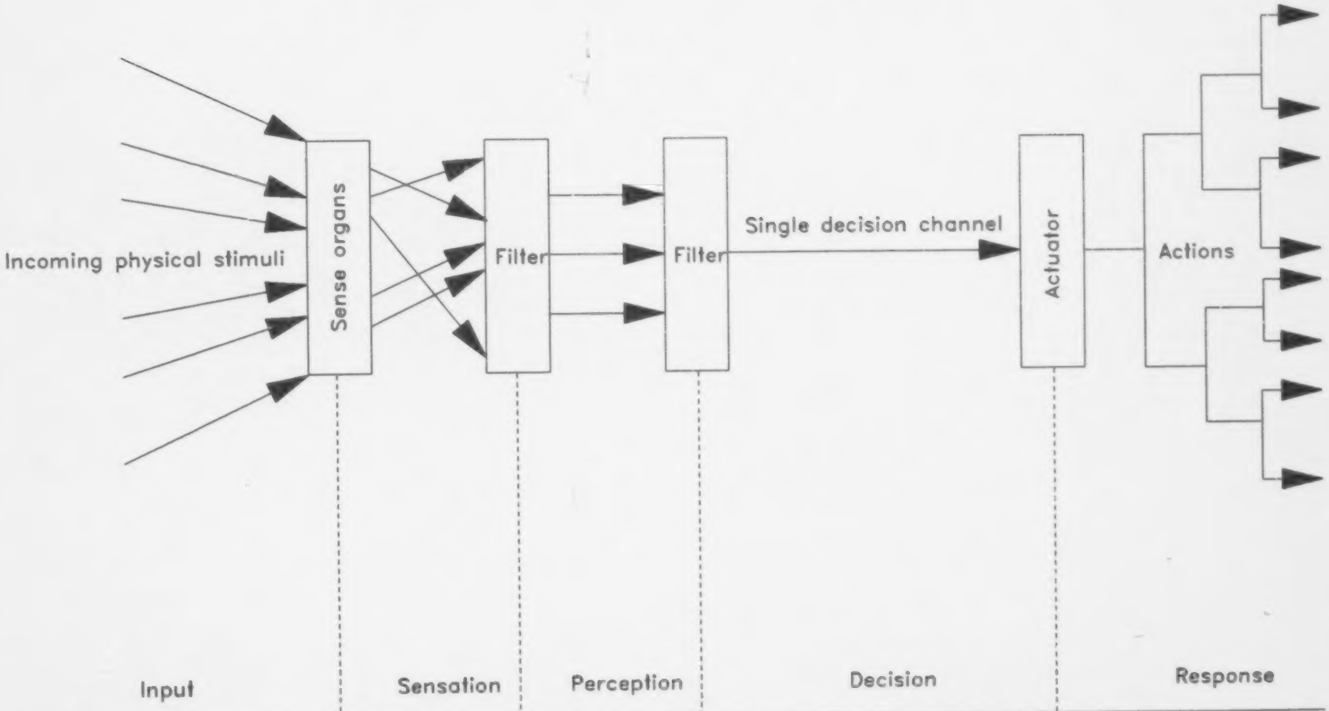
[1] P.D. Olsen et al., *Parameters Affecting Stopping Sight Distance*, NCHRP Report No. 270 (Washington, DC: Transportation Research Board, 1984).

[2] M. Allnutt "Human Factors: Basic Principles," *Pilot Error, The Human Factors*, R. Hurst and L. Hurst (eds.) (London, England: Granada Publishing, 1983).

[3] Transportation Research Board, *Zero Alcohol and Other Options: Limits for Truck and Bus Drivers*, Special Report 216 (Washington, DC: National Research Council, 1987).

[4] Commercial vehicle operator licensing was changed dramatically by passage of the 1986 Commercial Motor Vehicle Safety Act, but the gradual phasing in of the program will delay the full impact of the legislation. The Commercial Driver's License Program of the Department of Transportation established five key dates as milestones for identifying and removing unqualified drivers from the road. For further information on the program, see ch. 3.

Figure 6-1.—Human Information Processing Sequence


Incoming physical stimuli
Sense organs
Filter
Filter
Single decision channel
Actuator
Actions
Input
Sensation
Perception
Decision
Response

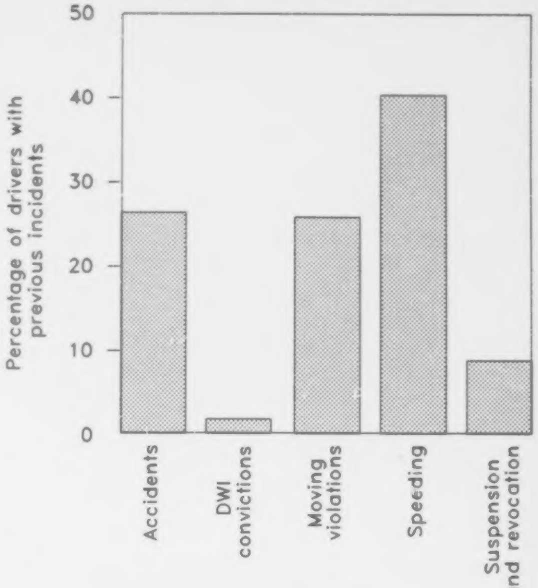
SOURCE: Office of Technology Assessment, 1988; adapted from R. Hurst and L. Hurst (eds.), *Pilot Error, The Human Factors* (London, England: Granada Publishing, 1983).

ground checks and pre-employment physical examinations that DOT requires. Thorough prehiring evaluation can pay major dividends for management. One company uses a carefully developed test to help determine which applicants have the coordination, physical capability, and mental attitude to handle a tractor-trailer combination. The company has found a very strong correlation between the driving skill level exhibited during the evaluation and driver performance after hiring.[5] Moreover, when a driver eventually does have an accident, the cause is frequently a driving behavior characteristic that the test had identified as needing improvement. Such a diagnostic tool can provide a carrier with invaluable information to use in both initial driver training and retraining.[6]

Automotive safety research shows that those who indicate on a screening test that they are risk-takers are likely to be relatively aggressive in their driving behavior, less mindful of cautions about safety, and more likely to drive longer hours without rest. On the other hand, risk averse drivers, though not necessarily more skilled, are likely to give other highway users a way out in dangerous road situations and to show prudence in their driving decisions.[7] However, not all carriers understand the benefits of careful screening—a DOT study of carriers rated unsatisfactory in the Pacific Northwest found that 35 percent of the firms had unsatisfactory driver qualification procedures.[8]

Although driving a truck requires different skills than driving a car, one study that examined the relationship between a truck driver's driving records in his personal vehicle and in his truck found a strong similarity between the records. OTA analysis of the National Accident Sampling System data also shows that heavy truck drivers involved in accidents have received citations for previous safety violations, particularly for speeding (see figure 6-2). However, the prior record in the truck is a better predictor than either the record in the private vehicle or the total record including both private and commercial driving.[9]

Figure 6-2.—Incident History of Heavy Truck Drivers Involved in Accidents



KEY: DWI = Driving while intoxicated.

SOURCE: Office of Technology Assessment, 1988; based on National Accident Sampling System data.

Management interest in more stringent screening procedures may be thwarted by demographic and economic pressures. The Department of Labor reports that the truck driving work force is expected to increase 17.2 percent by 1995, placing truck driving among the 37 fastest growing occupations out of 500 studied.[10] At the same time, industry analysts forecast that finding qualified truck drivers will become more difficult over the next decade, with a 30-percent reduction in the available driver pool expected by 1992. This reduction will be due to retirements, drug screening, tighter Federal driver requirements and licensing standards, a shrinking national labor force, and the perception that truck driving is a high-stress job requiring excessive time away from home.[11] Truck driver wages rose just over 20 percent between 1979 and 1987, as compared to a rise of almost 50 percent for all occupations.[12]

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[5] John Dannemiller, Leaseway Transportation Corp., in U.S. Congress, Office of Technology Assessment, "Transcript of Proceedings—OTA Workshop on Human Factors and Truck Safety," unpublished transcript, May 19, 1987, p. 43.

[6] Fred E. Vanosdall, Michigan State University, personal communication, May 18, 1988.

[7] Richard Schwing, General Motors Research Laboratories, in Office of Technology Assessment, op. cit., footnote 5.

[8] Robert Bleakley, Federal Highway Administration, in Office of Technology Assessment, op. cit., footnote 5, p. 65.

[9] Shirley B. Geissinger et al., *The Relationship Between a Truck Driver's Performance in a Personal Vehicle and in a Large Truck* (Chapel Hill, NC: University of North Carolina, Highway Safety Research Center, June 1986).

[10] National Transportation Safety Board, *Training, Licensing and Qualification Standards for Drivers of Heavy Trucks*, Report No. NTSB/SS-86/02 (Washington, DC: Apr. 17, 1986), p. 5.

To meet its needs, industry may have to resort to nontraditional labor sources, such as women and minorities, and increase wages. Recent proposals to allow 18- to 20-year-olds to operate commercial vehicles and heavy trucks as on-the-job trainees are a result of the shrinking driver pool. These proposals raise safety concerns, since accident statistics point directly at young drivers as a high-risk group.

Thus, although the importance of the selection process in screening out unqualified drivers is well recognized by many carriers, the need for personnel may cause the numbers of problem drivers behind the wheel to grow. Steps may be required to bolster application of uniform and stringent driver selection practices throughout the industry.

Alcohol and Drug Use Among Drivers

Although currently being revised, Federal Motor Carrier Safety Regulations now prohibit possessing, being under the influence of, or using an intoxicating beverage or drug while on duty, or consuming an intoxicating beverage within 4 hours of going on duty. Furthermore, a person is not qualified to drive if he or she has a current clinical diagnosis of alcoholism or drug dependency. These rules were based on the knowledge that driving performance is directly affected by intoxication or the influence of drugs. While the reaction to the ingestion of drugs and alcohol varies depending on the individual,[13] studies show that, for the majority, human performance is degraded by blood-alcohol concentration (BAC) levels of 0.05 or even lower. Epidemiological studies also indicate that the risk of being involved, as well as at-fault, in a motor vehicle accident begins increasing at low BAC levels.[14] This is in contrast to a legal standard for intoxication in highway driving currently set at 0.10 BAC in most States.[15]

Many of these research findings are based on automobile driving performance, and heavy vehicle drivers operate more complicated equipment on roadways often designed for smaller vehicles. Previous studies suggest that although more skilled persons are better able to compensate for the effects of alcohol than those less skilled, even skilled drivers show a decreased ability to handle complex tasks at low BAC levels.[16] Data analysis clearly correlates drinking with truck accident severity (see figure 4-6 in chapter 4). Recognizing the dangers of alcohol consumption and driving, one large petroleum refining company that sells fuel to truck stop operators has written provisions into its service contracts forbidding the sale of alcohol at those stops.[17] Alcohol use is a problem that cuts across driver classifications as shown in tables 6-1 and 6-2.

Table 6-1.—Drinking-Related Accidents by Driver Classification

	Number of drivers	
	Drinking involved	Drinking not involved
Noncommercial	856	90,234
Full time	3,555	579,260
Part time	205	27,100
Owner-operator	518	66,996
Leased	546	11,832
Other	303	2,319

SOURCE: Office of Technology Assessment analysis of National Accident Sampling System data, 1981-85.

Table 6-2.—Drinking-Related Accidents by Carrier Classification

	Number of drivers	
	Drinking involved	Drinking not involved
Noncommercial	856	90,234
For-hire/common	856	179,662
For-hire/contract	1,258	194,806
Private	1,932	242,130
ICC Exempt	1,142	51,770
Other	151	20,163

SOURCE: Office of Technology Assessment analysis of National Accident Sampling System data, 1981-85.

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[11] Jim Windsor, "Serious Accidents: Manpower Shortages vs. Driver Quality," *Heavy Duty Trucking*, July 1987, p. 18.

[12] Joanne F. Casey, American Trucking Associations, Statistical Analysis Department, "An Assessment of the Truck Driver Shortage," unpublished manuscript, Aug. 10, 1987, p. 7.

[13] G.C. Drew et al., *Effect of Small Doses of Alcohol on a Skill Resembling Driving* (London, England: Her Majesty's Stationary Office, 1959).

[14] Transportation Research Board, op. cit., footnote 3, p. 40.

[15] If the Secretary of Transportation does not issue a regulation by October 1988, the blood-alcohol concentration for commercial vehicle drivers will automatically drop to 0.04, consistent with present regulations for aviation crews and railroad engineers.

[16] Transportation Research Board, op. cit., footnote 3, p. 57.

[17] Gisela Vallandigham, vice president of membership, National Association of Truck Stop Operators, personal communication, Mar. 15, 1988.

Evaluations of other drug-related impairment levels are far more primitive. Reliable evidence about the effects of drugs on drivers is sketchy, and most States do not test for drugs other than alcohol. Further research on the subject is needed for marijuana and other controlled substances before adequate impairment guidelines can be established. The National Transportation Safety Board (NTSB) hopes to establish some guidelines for impairment levels as part of its current drug and alcohol study; the study is currently scheduled for completion in 1989.[18]

Drug Testing

Many carriers require pre-employment drug and alcohol testing. When one company started a drug-alcohol testing program 2 years ago, 15 percent of the applicants tested positive in the first year.[19] A year later, only 8 percent of applicants tested positive; this company had sent a signal to prospective drivers that they need not apply if they have a drug or alcohol problem. Such individuals may seek employment from other carriers with different screening policies; indeed, one company in the Midwest reported that 47 percent of the applicants it screened had positive drug screens. Another carrier that conducted drug screening of current employees and job applicants found that 17 percent of the tests were positive.[20]

Where management fails to take assertive action, the drug problem among employees can become entrenched. For example, one motor carrier safety director found evidence of marijuana use while making spot checks of his company's tractors. A subsequent investigation led to the discharge of 50 percent of the drivers at the terminal involved. In another instance, a laboratory that performs drug screening for several major carriers found that even for repeat examinations, 13 to 18 percent of the tests were positive. In some cases, this occurred despite the fact that employees were given 30 to 60 days advance notice of the tests.[21] OTA staff found that drugs are readily available at truck stops, some of which are well-known among drivers for drug activity, and CB radios are used openly for advertising or soliciting drugs.[22]

Appropriate formal procedures for periodic drug and alcohol testing of employees have been the subject of much debate. Many motor carriers conduct testing on a calendar basis for all employees; others test a sample of employees.[23] The International Brotherhood of Teamsters' master freight agreement guidelines for physical examinations and for testing urine for marijuana and other classes of drugs generally follow standards set by the U.S. Department of Health and Human Services. Members can be tested during their regular DOT physical examinations and when probable suspicion or cause can be established.[24] Although the Teamsters represent many drivers working for large trucking concerns, the majority of drivers are not subject to this agreement. When an independent driver contracts with a larger carrier, however, he must abide by that company's policy. It has been estimated that carriers large enough to mount their own alcohol and drug abuse programs are responsible for less than one-third of the heavy trucks using the highways.[25]

In a survey of 1,762 truck drivers conducted recently in Florida, 33 percent of the drivers reported being previously tested for alcohol, and 38 percent reported being previously tested for drugs by the company they were presently driving for or to which they were leased. Owner-operators reported the lowest frequency of testing, 29 percent for alcohol and 31 percent tested for drugs, respectively. Drivers employed by for-hire carriers reported the largest percentage of prior testing. Attesting to concern about substance abuse among drivers, 73 percent of those surveyed stated that they support mandatory random alcohol and drug testing by employers.[26]

The reliability of the testing methods is of special concern for drug tests. The most accurate tests, which are also the most expensive ($30-$125), can produce 2 to 3 false positives per 100 tests. Because of the likelihood of false readings, laboratory experts urge a followup test. While many cost-conscious employers are not willing to pay for additional tests, others share information with the applicant and will re-evaluate the applicant if he or she takes a second test at personal expense.[27]

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[18] Pat Loach, project director, National Transportation Safety Board, personal communication, Mar. 18, 1988.

[19] Ken Thompson, Yellow Freight System, Inc., in Office of Technology Assessment, op. cit., footnote 5, p. 147.

[20] Richard Landis, Associate Administrator for Motor Carriers, testimony before the Senate Committee on Commerce, Science, and Transportation, Feb. 18, 1986.

[21] Ibid., p. 28.

[22] An OTA analyst made several trips with over-the-road drivers in conjunction with this project.

[23] Thomas Donohue, President and CEO, American Trucking Associations, testimony before the Senate Committee on Commerce, Science, and Transportation, Feb. 18, 1986.

[24] Transportation Research Board, op. cit., footnote 3, p. 132.

[25] Ibid., p. 132.

[26] Regular Common Carrier Conference, "Highway Common Carrier News Release," Nov. 16, 1987.

Some companies are sensitive to the counseling needs of drug and alcohol abusers. One carrier's employees are given a drug test as part of their annual physical examination; they are notified of their scheduled appointment 30 days in advance. The company feels a responsibility to assist the driver in obtaining treatment if the employee informs management prior to the physical of a drug or alcohol problem.[28]

More stringent methods for detection of alcohol use by truck drivers while on the road have also been discussed as enforcement measures. A recent study conducted by the Transportation Research Board (TRB) concluded that the technical ability to detect and measure BAC levels of less than 0.05 is available with current screening and testing devices. However, the legal authority of public enforcement officers to enforce a law based on a low BAC standard with breath-screening devices has not been definitively established. If the ability to do so survives legal scrutiny, the TRB report indicates cost-effective enforcement could be carried out by screening drivers at truck weigh stations and as part of vehicle safety inspections. Blood tests could be mandatory after injury-producing accidents. TRB estimates that vigorous enforcement of this kind would save between 80 to 140 lives annually at a minimum BAC level of 0.10, 110 to 190 lives at a 0.04 BAC threshold, and 130 to 250 lives at a limit of 0.00 BAC. The total public and private costs for enforcement at each level is estimated at $30 million, $40 million, and $50 million, respectively.[29]

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[27] Greg Borzo, "Motor Carriers Institute Pre-Employment Drug Tests," *Traffic World*, June 15, 1987, p. 12.

[28] Ken Thompson, Yellow Freight System, Inc., in Office of Technology Assessment, op. cit., footnote 5, pp. 147-148.

[29] Transportation Research Board, op. cit., footnote 3, p. 2.

MANAGEMENT APPROACH

Driver attitude is a major influence on truck safety and that attitude is affected by company management philosophy and the work environment. A carrier that actively promotes safety and rewards good practices establishes safety as a major driver responsibility. This approach often requires extra effort to develop staff leadership and provide safety incentives; however, under such management, drivers are more likely to view themselves as professionals, accountable for the safe operation of their vehicles. Incentive programs may include cash bonuses, award programs, group recognition, and distribution of patches, pins, wallet cards, rings, and even stock for different levels of achievement.[30]

One firm has adopted a formal corporate approach to safety that focuses on: 1) driver selection, 2) driver training, 3) driver conditioning, and 4) driver management.[31] Communication is an important safety ingredient at another firm. For instance, group discussions between management and drivers encourage driver feedback and provide management with constructive information about operations. Good rapport between labor and manage-

QUALITY AND SAFETY
THRU OUR
PRIDE IN PERFORMANCE

Photo credit: Karen Mathiasen, OTA staff

Management emphasis on safety can focus drivers on its importance.

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[30] John J. Killilee, Consolidated Freightways, in Office of Technology Assessment, op. cit., footnote 5, p. 152.

[31] Dannemiller, op. cit., footnote 5, pp. 42-46.

ment brings better agreement about organizational goals and how to achieve them.

One management consulting company has developed a program to establish a positive corporate attitude toward safety through management strategies, technical training, and operations. The program addresses vehicle inspection, driver selection, drug screening, driver health, hazardous materials hauling, city and over-the-road driving, hours of service, accident reporting, worker's safety, and security.[32] Another company that produces industry-related instructional material is developing a series of video-training programs on trucking. Safety programs will cover driver fatigue, road vision, driving a bobtail with an empty trailer, and professionalism. Technical training programs will include brake systems, motors, truck specifications, and gauges and switches.[33] Numerous other trucking associations and commercial firms also publish training materials. No widely accepted standards exist for evaluating any of these programs.

Companies that have mounted carefully structured and intensive safety efforts have found major cost benefits in the quality of customer service, productivity improvements, and accident avoidance leading to lower insurance costs.[34] United Parcel Service (UPS), one of the most successful carriers in the country, is such a company, and its accident rate is one-tenth the national average. Box 6-A describes UPS operations and safety management techniques.

Creating an environment that does not compromise safety requires management to balance regulatory requirements, such as hours-of-service rules, and customer service needs—just-in-time deliveries, for example. Intense competition for freight and market share provides a powerful incentive to increase productivity, utilize capacity, and push drivers to the limit of their ability to stay alert at the wheel. Some companies inform customers directly that trade-offs exist between costs and quality of service, and that safe, reliable service is worth slightly higher rates.[35]

However, drivers complain that shippers, brokers, and dispatchers often push hard for unrealistic delivery schedules that violate regulations. While an oversupply of carriers in the mid-1980s enabled shippers to shop around for carriers willing to take a load on any terms, this is less true today. Nonetheless, drivers resent being held responsible for violations of weight laws or hours-of-service regulations. The American Trucking Associations, Inc. (ATA) advocate placing responsibility directly on shippers for demanding that truckers drive longer or faster than is legal to deliver goods.[36] Others claim that the need to use brokers places additional constraints on both shippers and carriers.[37] The State of Rhode Island has acknowledged that drivers are often subject to strong pressure from carrier management and imposes fines and citations for motor carrier owners whenever their drivers are cited.[38] One expert finds that drivers feel less pressured to take loads exceeding weight limits in States where this change in policy has occurred.[39]

The Federal Highway Administration (FHWA) has two small, new programs that address similar issues. The Commercial Accident Prevention and Evaluation Program was started in 1987 to identify carriers with high at-fault accident rates and develop countermeasures to reduce risks. The Educational and Technical Assistance Program is a nationwide safety information program aimed at carriers, drivers, and industry associations. Mass mailings of literature identify highway locations with high accident rates and detail accident avoidance techniques.[40]

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[32] Jay Deragon, president, Megasafe, personal communication, Oct. 12, 1987.

[33] Bernadette Williamson, senior producer, The Kalamazoo Writing and Video Co., Merv Orr's Transportation Training Corp., personal communication, Feb. 25, 1988.

[34] Robert D. Powell, vice president, Finance, Arthur H. Fulton, Inc., personal comunication, Jan. 26, 1988.

[35] Dannemiller, op. cit., footnote 5, p. 46; and ibid.

[36] Donohue, op. cit., footnote 23, p. 50.

[37] James Johnston, Owner-Operators Independent Drivers Association of America, in Office of Technology Assessment, op. cit., footnote 5, pp. 240-241.

[38] William Maloney, associate administrator for motor carriers, Rhode Island Public Utilities Commission, personal communication, Feb. 2, 1987.

[39] Patricia Waller, University of North Carolina, Highway Research Center, personal communication, May 19, 1987.

[40] Robert Bleakley, Federal Highway Administration, personal communication, July 6, 1988.

Box 6-A.—United Parcel Service: A Case Study of Successful Safety Management

The United Parcel Service (UPS) "feeder" drivers, who maneuver doubles, triples, and semitractor-trailers over the Nation's highways to move parcels to distribution facilities, boast an enviable safety record. For 565 million miles driven in 1986, UPS reported 141 accidents to the Department of Transportation, approximately one reportable accident per 4 million vehicle-miles.[1] This low accident rate, only one-tenth the national average, can be attributed to efforts made by the company to avoid factors most commonly associated with accidents such as speeding, fatigue, lack of training, and poor equipment maintenance. At UPS, driver qualifications are high, driver schedules are regular, training procedures are rigorous, and maintenance practices are stringent.

Interstate drivers are recruited from among those who have been employed at UPS for at least 1 year as package drivers. Ninety-five percent of these new interstate drivers are 25 years of age or older. They have no avoidable accident on their records in the past 12 months, and no DWI conviction in the previous 3 years. Applicants participate in a UPS training program that consists of two 40-hour weeks. During the first week, defensive driving methods are taught to all applicants; they are also trained to conduct pre-trip inspections, operate tachographs, and handle hazardous materials. During the second week, applicants are assigned actual UPS routes to become familiar with the job pressures and responsibilities of feeder drivers. At the end of each week, all trainees take a road test. Each time, an average of 60 percent of the trainees pass, and applicants who fail must wait 2 years before reapplying.

Based on the theory that even good drivers can develop bad habits, UPS trainers provide drivers with on-the-job-supervision four times a year. Equipped with a 120-item checklist, the trainers supervise recurring training for both package and highway drivers to ensure that driving methods remain consistent and safe.

The UPS scheduling format is designed to avoid driver fatigue. While UPS operates on a 24-hour basis, no driver is scheduled for more than 9 or 10 hours at a time, and each driver returns to the point of origin at the end of a shift. Based on seniority, drivers choose schedules for a minimum of 6 months and therefore need not constantly adjust to different shifts. Drivers' shifts include time allocated for a pre-trip inspection, turn around time, on-the-road time, and time to maintain current logs and complete and submit a vehicle condition report. Their schedules are determined by the posted speed limits and terrain, and drivers are expected to stay within the speed limit and observe hours-of-service regulations. Drivers work as directed, and in situations where driving time does not absorb a full shift, may aid in handling packages.

When an accident does occur, drivers are expected to adhere to a routine reporting system. Even if the UPS driver is not found liable, a company investigation takes place to determine if the accident was avoidable; if so it is noted on the driver's record. Approximately 65 to 70 percent of accidents are labeled avoidable by the company, and drivers involved in the accidents are immediately subject to additional training in order to be recertified.

Finally, UPS provides strong incentives for drivers to maintain excellent driving records. Safe drivers are recognized annually with prizes and awards; those drivers who complete 20 years of safe driving are admitted to the UPS "Hall of Fame."

Maintenance standards for UPS vehicles are strict. Trailers receive preventive maintenance inspections (PMIs) every 6 months, tractors receive PMIs every 16,000 miles, and package trucks receive PMIs every 4,000 to 6,000 miles. Vehicles are assigned to the same drivers, because drivers familiar with a vehicle are considered more likely to recognize any change in its performance or appearance. Vehicles are also serviced and maintained by the same mechanic.

Maintenance practices are intended to keep UPS vehicles on the road longer than the average 3 to 4 years. While many carriers replace trucks once engines have worn out, UPS management prefers to replace the engine, as the vehicle body is designed by UPS and is built for long life. Consequently, the average vehicle age for the company is approximately 15 years. Other preventive maintenance measures taken include pre-trip inspections, with a 120-item checklist, and post-trip vehicle reports.

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[1] An accident must be reported to the Department of Transportation if there is some bodily injury, a fatality, or at least $4,400 dollars worth of damage. The reporting rate for United Parcel Service includes all accidents under these circumstances, regardless of who is at fault.

DRIVER TRAINING

OTA accident data analysis shows that level of driver training is the second most frequently cited factor for motor carrier accidents. Although reliable statistics do not exist, industry experts estimate that the majority of drivers have not had adequate formal training. Research indicates that experienced drivers often acquire bad driving habits that could be corrected through remedial or inservice training. A number of carriers have recognized the importance of thorough training and have developed their own programs, described later in this section.

At present, no Federal requirement exists for drivers of heavy trucks to receive formal training, nor does a single State impose a training requirement for all drivers of heavy trucks.[41] Federal regulations for the Commercial Driver's License establish qualifications on the basis of whether a person can safely operate the vehicle and secure the load to be carried, skills that can be acquired through either training or experience. Many motor carriers do not impose specific training requirements, but require applicants to have a minimum of 2 years of on-the-road experience.[42] This poses difficulties for graduates of accredited training programs, since the only way to meet this demand is to drive for a firm that has no such requirement.

Formal truck driver education is available through proprietary truck driver training schools, nonprofit public education institutions, and in-house motor carrier training programs. The number of proprietary training programs is estimated at around 200, with fewer than 10 being in-house programs. Tuition ranges from $350 to $5,000. Course length, qualifications of the instructors, student/teacher ratios, and, most importantly, time spent on the road driving vary widely among programs.[43] A survey of truckers in Florida indicated that 23 percent of the 1,800 respondents reported receiving formal driver training school instruction prior to becoming a professional driver; the average time as a truck driver was 15 years.[44]

Training Standards

Truck driver training schools are subject to oversight from various licensing and accrediting bodies. Some States, such as Maryland, Pennsylvania, and Indiana, require driver training schools to be licensed, although different agencies are assigned this oversight responsibility. While these authorities often establish a minimum number of course hours, requirements for course content usually are not specified.[45] Some schools have been accredited by the National Association of Trade and Technical Schools or the National Home Study Council. The vast majority of programs, however, have not been accredited by either organization.

DOT issued proposed minimum standards for training tractor-trailer drivers in 1984, in an effort to establish guidelines for truck driver training. The standards call for a minimum 320-hour course lasting 8 weeks, if taken on a full-time basis. Course content included basic truck operation, safe operating practices, advanced operating practices, vehicle maintenance, and nonvehicle activities. The standards also covered instructor qualifications, school facilities, graduation requirements, and student placement. No final action was ever taken on the proposed standards, although the Office of Motor Carriers (formerly the Bureau of Motor Carrier Safety) published a ready-made curriculum, *Model Curriculum for Training Tractor-Trailer Drivers*, in

Photo credit: Tse-Sung Wu, OTA staff

A driver receives on-the-road instruction.

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[41] National Transportation Safety Board, op. cit., footnote 10, p. 7.

[42] Phil Willis, "Novice Finds Employment Catch-22," *Truckers USA*, vol. 4, No. 30, July 21, 1987, p. 29.

[43] National Transportation Safety Board, op. cit., footnote 10, p. 9.

[44] Regular Common Carrier Conference, op. cit., footnote 26, p. 1.

[45] National Transportation Safety Board, op. cit., footnote 10, p. 11.

1984. Included in the 2,500-page document are instructions for the school administrator, instructor, and student. These standards cannot be used for evaluating existing schools until their validity has been tested with actual schools and students, and DOT has not taken steps to do this.

The Professional Truck Driver Institute of America (PTDIA) was formed by industry in 1986 to certify acceptable training schools. PTDIA has adopted a curriculum based on the Federal model and started certifying driver training programs in mid-1988. PTDIA is funded entirely by industry and has both carrier and public enforcement representatives on its Board of Directors. The organization emphasizes the critical importance of the number of hours of hands-on, behind-the-wheel driving time a student receives.[46] While PTDIA's activities have been supported by many in the industry, the Commission of Accredited Truck Driving Schools maintains that driving schools should be free to structure their curricula to meet their educational objectives.[47]

Training Programs

Although relatively few in number, carriers' in-house training activities can be very effective (see box 6-A on UPS, for an example). In 1980, a large general commodities motor carrier implemented a training program to instruct all new drivers in the safe handling of the vehicle and cargo and has reported a 14-percent decrease in line-haul accident frequency despite a 38-percent increase in line-haul mileage.[48] In another case, a trucking firm's commitment to training led to the provision of a curriculum, equipment, instructors, and course evaluations as aids to outside training schools.[49] This firm's screening test for prospective drivers has been carefully crafted to identify driving patterns and habits that have the potential to cause accidents.

The insurance industry has also developed training programs to promote safe driving behavior. One insurance company offers a 5-day seminar, open to driver trainers, safety personnel, maintenance supervisors, and to the management of fleet policyholders. It includes both classroom and behind-the-wheel experience. The examination of several fleets' safety records before and after personnel received training showed consistent reductions in accident frequency and loss rate per vehicle.[50]

An alternative approach is developing a truck driver apprenticeship program so that new drivers will receive qualified supervision and develop safe driving habits. In the Netherlands, for instance, prospective new drivers undergo a 2-year apprenticeship.[51] There is currently no organized apprenticeship program for heavy truck drivers in the United States, although the issue has been raised in the past and is again being discussed.

Recurrent training of employees is important not only to keep experienced drivers up-to-date, but to identify bad habits that may have developed over time. For example, research in Europe has shown how little perception even experienced drivers have of their actual speed when they are in a monotonous or repetitive driving situation.[52] On U.S. highways, difficulties with speed perception are acute when a driver leaves the Interstate system and moves onto two-lane roads, where speed limits, access, median control, and signs are quite different.[53]

Keeping drivers physically fit, through physical conditioning, weight control, and aerobic capacity can reduce fatigue and stress. One carrier is installing a physical conditioning program nationwide for its line-haul drivers to assist them in developing physical and mental stamina to cope with long-haul driving.[54]

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[46] Thomas M. Strah, "Truck Driver Training: A Matter of Standards," *Transport Topics*, Jan. 18, 1988, p. 16.

[47] James J. McAlpin, vice president, Administrative Services, USA Training Academy, personal communication, Feb. 4, 1988.

[48] Strah, op. cit., footnote 46, p. 8.

[49] Dannemiller, op. cit., footnote 5, pp. 43-44.

[50] *Southern Motor Cargo Magazine*, "The Driver is the Decision-Maker," May 1984.

[51] National Transportation Safety Board, op. cit., footnote 10, p. 21.

[52] David Lowe, *The Tachograph* (Solihull, England: Fleet Planning Limited, 1982), p. 213.

[53] James Johnston, Owner-Operators Independent Drivers Association of America, in Office of Technology Assessment, op. cit., footnote 5, pp. 116-117.

[54] Dannemiller, op. cit., footnote 5, p. 45.

SHARING THE ROAD WITH THE DRIVING PUBLIC

Heavy vehicle operators often claim that most automobile drivers are unaware of the limitations and space requirements of heavy trucks. The longer, wider trucks now permitted are difficult to see around and require longer distances to pass than current highway designs allow. Heavy truck drivers operating in congested areas try to leave enough distance between their own and other vehicles for a complete stop. However, automobile drivers often cut sharply in front of trucks, making it difficult to avoid an accident—for which the truck driver may be cited.

Education programs for automobile drivers could help make them aware of safety issues related to sharing the road with trucks. States such as Tennessee are considering reorganizing their driver licensing programs to include material and questions on truck safety. An information videotape for automobile drivers on sharing the road with trucks is another possibility;[55] it could be shown to people waiting to obtain driver licenses.

Education programs to inform small carriers about better road safety have also been developed. Available through the National Safety Council and ATA, these materials describe how a carrier as small as a 10-person trucking company can implement an effective safety program.

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[55] Paul Melander, Tennessee Public Service Commission, personal communication, May 19, 1987.

HOURS OF SERVICE

The hours-of-service rules in effect today are essentially the same as those promulgated in 1937 and 1938 by the Interstate Commerce Commission (ICC).[56] The regulations prohibit carriers from requiring or permitting any driver to drive more than 10 hours at a time after being on duty more than 15 hours. Drivers must have 8 consecutive hours off-duty before driving again. In addition, drivers are prohibited from driving after 60 hours of on-duty time in any 7-day period, or 70 on-duty hours in any period of 8 consecutive days.[57] Drivers are required to keep records of their driving in a logbook that must be available for inspection by enforcement officers at all times.

Complex and difficult to enforce, the hours-of-service rule is subject to problems ranging from falsification and abuse of logbooks by drivers to loose interpretations of "on duty" and "off duty" by management. The 15-hour on-duty period can be accounted for during the course of a driver's overall duty day in any number of ways. For example, the driver's employers may "relieve" him of duty—responsibility for the vehicle—for meals and rest breaks. Tiring and strenuous activities, such as loading and unloading performed by the driver, are not considered part of driving time, although they are considered duty time and usually contribute to fatigue. Furthermore, 8 hours of off-duty time often does not afford drivers adequate time to travel to and from their jobs, eat, bathe, and attend to life's other requirements, as well as to get adequate undisturbed sleep. Finally, the illegal practice of requiring a driver to wait at a terminal in an "off-duty" status for a work assignment contributes to fatigue prior to the start of a driving tour.[58] These factors help explain why many drivers keep double logbooks (one for enforcement officers and one for themselves) or make false entries.

Many drivers are compensated on the basis of how many miles they drive during a pay period. A long-haul driver faces a choice between violating hours-of-service rules and maintaining his income if bad weather, highway conditions, or shipper-related delays prevent him from driving an acceptable number of miles. Drivers risk accidents and deny themselves adequate sleep by accepting loads that require many consecutive hours of driving to reach a final

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[56] Trucking is not subject to the Fair Labor Standards Act. Carriers do not have to pay time-and-a-half for a greater than 40-hour work week. This creates an incentive for a carrier to hire the fewest drivers possible and to have them work the longest hours possible in order to maximize profits.

[57] United States Court of Appeals for the District of Columbia Circuit, Professional Drivers Council v. Bureau of Motor Carrier Safety, Petitioners' Brief, No. 81-2283, Mar. 8, 1982.

[58] Ibid., p. 9.

Photo credit: Michael Hines, OTA staff

Federal regulations require drivers to record their hours of service.

destination on time. Nonetheless, drivers sometimes boast of their long-distance driving accomplishments and stoically shrug-off unrealistic shipper deadlines.[59]

ICC, and subsequently DOT, have recognized that the hours-of-service rules are subject to abuse. In 1972, the Bureau of Motor Carrier Safety (BMCS) in DOT initiated a comprehensive study of the relationship between dangerous levels of fatigue among truck drivers and the current hours-of-service regulations.[60] The report compiled and analyzed scientific and medical data reflecting driver performance and physiological responses collected during 195 truck and bus runs. A total of 1,550 hours of continuous data was obtained and analyzed on 62,000 miles of highway truck travel in all parts of the country, and in all weather and traffic conditions. The study concluded:

> ". . . driver performance deteriorates, driver alertness . . . diminishes, rest breaks become less effective, and accident probability increases, all within the current 10-hour daily limitation on driving time. It [the regulation] is further at odds with a good deal of anecdotal evidence from the drivers to the effect that they do suffer from considerable fatigue but are

Photo credit: Land Line

On duty activities such as loading and unloading, in addition to driving, contribute to driver fatigue.

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[59] An OTA staff member heard one operator in Pennsylvania at 8:00 a.m. admit to having to be in Burbank, California at 11:00 a.m. just 2 days later.

[60] In 1985, the Bureau of Motor Carrier Safety was reorganized and renamed the Office of Motor Carriers.

unwilling to admit it because of the feared economic consequences.[61]

This study focused on scheduled relay operations of large common carriers whose drivers were able to plan their rest,[62] and no formal regulatory action was taken. BMCS acknowledged that further research was needed to provide data for revising hours-of-service rules, especially on drivers whose assignments were irregular in frequency, duration, and starting times, and who often could not predict when they would be driving.

The second phase of BMCS's fatigue study, issued in 1978, found that relay drivers operating irregular schedules suffered greater fatigue, physiological stress, and performance degradation than drivers working similar hours on a regular schedule. Fatigue effects were evident after about 8 hours of relay truck driving on a regular schedule and considerably earlier when the schedule was irregular. Cargo loading increased the severity of fatigue associated with irregular working schedules.[63] The reported findings were considered conservative, since the drivers in the study were allowed 8 hours of sleep each day.

A separate, concurrent study of accident data found that the length of driving time by itself was not related to frequency or severity of truck accidents. However, the combination of driving and nondriving time could be related to driver fatigue and play a role in accident occurrence.[64] Following the results of these studies, BMCS subsequently issued a Notice of Proposed Rulemaking and conducted public hearings in several cities around the country. By the end of 1978, BMCS had accumulated what it considered to be sufficient information to justify amending the hours-of-service regulations.[65] Table 6-3 provides a summary of hours-of-service regulation options that BMCS considered.

In 1981, however, the agency terminated the rulemaking action and closed the docket, citing the absence of a direct relationship between the hours-of-service rules and accidents. Also, in 1981 BMCS commissioned an economic study of the cost of modifying the hours-of-service rules to conform with Office of Management and Budget and DOT policy requirements. The projected costs of each of the government's three major options were considered to be significantly greater than the projected benefits.[66]

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[61] William Harris et al., Human Factors Research, Inc., *A Study of the Relationships Among Fatigue, Hours of Service, and Safety of Operations of Truck and Bus Drivers*, Report No. BMCS-RD-71-2 (Washington, DC: U.S. Department of Transportation, Federal Highway Administration, Bureau of Motor Carrier Safety, November 1972), p. xi.

[62] Robert A. Kaye, Director of the Bureau of Motor Carrier Safety, memo to Arthur L. Fox, II, Esq., Aug. 21, 1973.

[63] Robert R. Mackie and James C. Miller, Human Factors Research, Inc., *Effects of Hours of Service, Regularity of Schedules, and Cargo Loading on Truck and Bus Driver Fatigue*, Report No. DOT HS-803 799 (Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration, October 1978).

[64] Safety Management Institute, *Analysis of Accident Data and Hours of Service of Interstate Commercial Motor Vehicle Drivers*, prepared for the Bureau of Motor Carrier Safety (Washington, DC: Aug. 11, 1978).

[65] United States Court of Appeals, op. cit., footnote 57, p. 18.

[66] Booz, Allen & Hamilton, Inc., *Assessment of the Impacts of Proposed Hours of Service Revisions*, prepared for the Bureau of Motor Carrier Safety (Washington, DC: June 24, 1981).

FATIGUE AND SLEEP NEEDS

Medically-related sleep disorders and occupationally-induced sleep disturbances seriously impair driving ability. Scientific literature makes clear that human performance is best at moderate levels of arousal. At low levels, the brain loses the capacity to make quick and informed decisions; at high levels, actions may be frequent, but ill-directed.[67] Fatigue and sleepiness are associated with low levels of arousal. Normal fatigue can be exacerbated by three categories of stress factors: 1) physical environment such as temperature and vibration; 2) physiological factors such as poor or inadequate sleep, drugs and alcohol, or irregular eating habits; and 3) psychological factors such as anger, fear, and frustration.[68] A distinction is sometimes made for drivers between single-trip fatigue, where an opportunity for recovery may exist; cumulative fatigue, in which recovery time between trips is not adequate; and chronic fatigue, which usually requires medical assistance. The behavorial symptoms of all three types

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[67] Allnutt, op. cit., footnote 2, p. 13.

[68] Ibid., p. 15.

Table 6-3.—Current and Proposed Hours-of-Service Regulations

Section	Current regulations	Option I	Option II	Option III
Driving time	10 hours	8 hours	12 hours	10 hours
On-duty time	15 hours	12 hours	12 hours	15 hours
Cumulative on-duty time	70 hours in 8-day period 60 hours in 7-day period	70 hours in 8-day period		70 hours in 8-day period 60 hours in 7-day period
Off-duty periods	8 hours 10 hours at home terminal 24 consecutive hours after driving during 6 days	8 hours at foreign terminal 12 hours at home terminal 24 consecutive hours per 7-day period, or 48 consecutive hours per 14-day period	8 hours at foreign terminal	8 hours
Meal period	None required	30 minutes after 7 or more hours on duty (logged as on duty)	30 minutes after 7 or more hours on duty (logged as on duty)	None required
Driving relief period	None required	30 minutes after 4 hours (logged as on duty), may include meal period	30 minutes after 4 hours (logged as on duty), may include meal period	None required
Intermittent off duty	Not prohibited	Prohibited	Not prohibited	Not prohibited
Duty tour limit	No specific limit	15 consecutive hours	12 consecutive hours	No specific limit
Sleeper berth	2 periods totaling 8 hours, neither less than 2 hours	2 periods totaling 8 hours, neither less than 2 hours	Any 8 consecutive hours off duty may include sleeper berth time and off duty combined if consecutive	2 periods totaling 8 hours, neither less than 2 hours
Time-of-day restrictions	None	None	None	Driving between midnight and 6 a.m. prohibited

SOURCE: Office of Motor Carriers, 1988.

of fatigue are similar, however.[69] Sound, adequate sleep is the best way to relieve fatigue, which is an independent variable affecting behavior and performance.

Off-duty time, as specified in the regulations, often does not translate into sleep or rest time, as it was intended to do, partly because of the way the body functions biologically. Sleep researchers have shown that the body typically functions according to a circadian, or 24-hour, cycle that includes regular, defined periods of rest. Thus, when a driver starts his off-duty time, he may not be biologically ready to rest. As an example, a driver who begins a driving day at 6:00 a.m. must stop to rest at 4:00 p.m., according to the regulations. However, unless this is his accustomed time for sleep, his circadian cycle is not ready for him to begin prolonged rest. The driver is likely to take a nap eventually, but can begin driving again at midnight, just when the body's normal circadian cycle prepares him for sleep.[70] As a result, his alertness level and ability to operate a vehicle will be severely impaired.

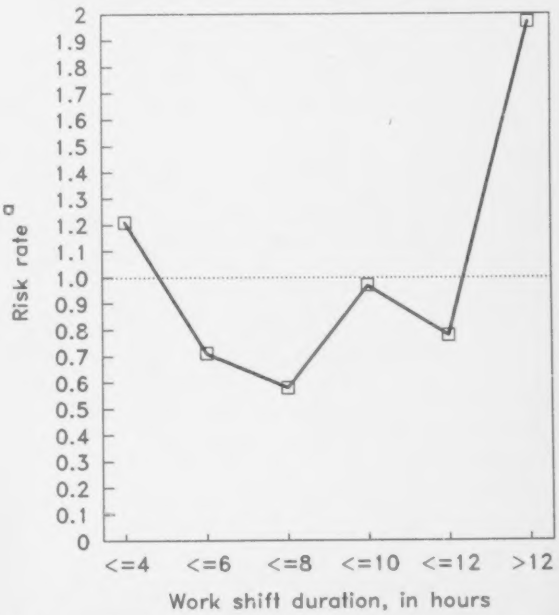
The type of rest can affect driver performance as well. One recent study of truck drivers found that sleep disruption associated with sleeper berth use causes fatigue and deterioration of truck driver performance. In fact, the accumulation of 8 hours rest split between two sleeper berth shifts increased the risk of death by a factor of three for truck drivers involved in accidents, according to the research results.[71] Moreover, research in Europe shows that accident involvement rates for truck drivers increase dramatically as work shift duration exceeds 8 hours (see figure 6-3).[72]

Research also shows that no amount of mental or physical conditioning can prepare people to operate at normal levels if deprived of sleep. Reaction times double or triple, and the brain lapses into sleep for fractions of seconds at a time, especially during monotonous circumstances, such as driving. Such factors may explain the disproportionate share of

Photo credit: Karen Mathiasen, OTA staff

Drivers who sleep in sleeper berths do not receive adequate rest, according to recent research.

Figure 6-3.—Truck Accident Risk Compared With Duration of Truck Work Shift



[a] A risk rate greater than 1.0 means that on average, more accidents occur at those times in a given work shift than would be expected on the basis of the number of truck trips.

SOURCE: Office of Technology Assessment, adapted from Patrick Hamelin, "Truck Driver's Involvement in Traffic Accidents as Related to Their Shiftworks and Professional Features," *Symposium on the Role of Heavy Freight Vehicles in Traffic Accidents* (Ottawa, Canada: Organisation for Economic Cooperation and Development, April 1987), vol. 2, pp. 3-107.

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[69] Ibid., p. 18.

[70] David Dinges, University of Pennsylvania, in Office of Technology Assessment, op. cit., footnote 5, pp. 73, 75, 127.

[71] Robin P. Hertz, "Sleeper Berth Use as a Risk Factor for Tractor-Trailer Driver Fatality," paper presented to the American Association for Automotive Medicine, New Orleans, LA, September 1987, pp. 9-10.

[72] Patrick Hamelin, "Truck Driver Involvement in Traffic Accidents as Related to their Shiftworks and Professional Features," *Symposium on the Role of Heavy Freight Vehicles in Traffic Accidents*, vol. 2 (Ottawa, Canada: Organisation for Economic Cooperation and Development, April 1987), pp. 3-107.

accidents that occur 1 or 2 hours into a driving shift,[73] and the high level of fatal accidents in the early morning hours between 5:00 and 7:00 a.m. According to sleep researchers, these are times when a person is particularly vulnerable to an accident-causing situation due to lowered alertness. Experts have found that an additional period of decreased alertness also occurs in the mid-afternoon.[74] Drugs and alcohol also affect a sleepy person much more strongly.[75]

Overweight, middle-aged males, a description fitting many truck drivers, are primary targets for a sleep disorder known as sleep apnea. A person suffering from sleep apnea rarely knows he or she suffers from the disorder, which is characterized by abnormal breathing at night and results in excessive daytime sleeping.[76] While some companies can schedule drivers so that their on-duty and rest hours occur at regular 24-hour intervals, others find it difficult. However, driver and management awareness of the reality of the effects of sleep deprivation and the vulnerability to accidents is a first step toward addressing the problem. Management sensitivity to the fact that some drivers may be less alert during driving tours due to a sleep disorder is also important.

The development of portable performance devices that detect, in a quick, reliable, and noninvasive manner, whether a person is reacting adequately to the road is a realistic long-term goal.[77] Such alertness devices, however, can create an environment of false security—an operator awakened by such a device may conclude that he can continue driving since he is awake. Alternatively, the driver could feel tired but decide to continue driving because he assumed that the alertness device would awaken him if he did fall asleep. The driver remains ultimately responsible for driving safely, for not substituting these devices for sleep, and for adhering to hours-of-service regulations.

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[73] Hertz, op. cit., footnote 71, p. 76.

[74] *Technology Review*, "Mathematics of Sleep," February-March 1987, p. 13.

[75] David Dinges, University of Pennsylvania, testimony before the Senate Committee on Appropriations, Subcommittee on Transportation, May 14, 1987.

[76] David Dinges, University of Pennsylvania, personal communication, May 19, 1985.

[77] Ibid.

TECHNOLOGIES TO ADDRESS HUMAN PERFORMANCE ISSUES

Carriers utilize numerous technologies to address management concerns about driver performance. For example, driving at high speed and the frequency and severity of accidents are strongly correlated (see chapter 4). Many carriers have chosen to install road-speed governors to limit the speed at which their tractors operate. These devices prevent the engine from generating more than the specified revolutions per minute, thus controlling the top speed of the vehicle. If maintained in good working order, governors can keep speed close to the legal limit and improve fuel economy as well.

Some States, such as Virginia, have outlawed the use of radar detectors in efforts to curtail speeding. Since the sole function of a radar detector is to recognize when radar is measuring the vehicle's speed, the prevalence of these devices in trucks indicates the potential for abusing speed limits. One recent study found that radar detectors encourage speeding, with the vehicles traveling fastest being most likely to be equipped with the devices. Moreover, of all vehicles on the road, tractor-trailers are the most likely to be equipped with radar detectors.[78] In another survey, 69 percent of owner-operators responding acknowledged that their vehicles were equipped with radar detectors.[79] Further study of driver behavior in radar detector-equipped vehicles is underway at the Texas Transportation Institute, although results are not yet available.[80] A separate survey of truckers in Florida found that 79 percent use radar detectors.[81]

The use of detectable radar by enforcement officers countered by the use of radar detectors and radar jamming devices by drivers reflect the conflicts between a highly competitive market and enforcing safety standards. While some segments of the carrier industry oppose legal sanctions against the devices, a joint petition to DOT was filed in spring 1988 by the American Automobile Association, ATA, the Insurance Institute for Highway Safety, and the National Safety Council, asking that they be prohibited.

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[78] *IIHS Status Report*, "Radar Detectors Spur Speeding," vol. 22, No. 3, Mar. 14, 1987.

[79] Owner-Operators Independent Drivers Association of America, "Survey," unpublished manuscript, Mar. 23, 1988.

[80] Dave Seiler, National Highway Traffic Safety Administration, personal communication, Apr. 11, 1988.

[81] Regular Common Carrier Conference, op. cit., footnote 26, p. 2

On-Board Recording Devices

Safety advocates have proposed using on-board recording devices to monitor compliance with hours-of-service rules. Units are currently available that can track distance traveled, driving time, breaks, daily rest periods, and speed limit compliance in addition to equipment-related information. These devices are discussed at length in chapter 5.

TRIPMASTER

Photo credit: Rockwell International Corp.

This on-board computer automatically records and stores the driver's hours of service.

Photo credit: Rockwell International Corp.

Computers that store driving records and hours-of-service information can be an efficient alternative to paperwork.

CONCLUSIONS AND POLICY OPTIONS

Improving human performance in an industry that must meet demanding time schedules to prosper is a difficult task. However, since human error is the largest single cause of motor carrier accidents, **OTA concludes that an aggressive Federal program to address human factors issues is a top priority.**

Legislation passed in 1986 requiring a Commercial Driver's License (CDL) is a major step in establishing uniform truck driver licensing standards and practices. **OTA concludes that for public safety, no exemptions to the requirement for a CDL are warranted. Exemptions of any kind would weaken the effectiveness of the legislation.** Congress will wish to monitor closely DOT's decisions as the CDL program is implemented. For example, abundant evidence exists that truck driver performance is impaired by BAC levels below 0.10 percent and that alcohol use increases both the likelihood and severity of accidents. **Congress may wish to ensure that DOT sets acceptable BAC levels for truck drivers at 0.04 percent (or lower), corresponding to the levels for airline crews and railroad engineers.**

Further, OTA concludes that drug abuse by truck drivers is a significant safety factor that deserves substantial study to prepare for regulation. The results of the current NTSB study will provide valuable information on levels of drug use and their contribution to driver impairment. However, more study will be necessary to determine the appropriate regulatory standards. A requirement for drug and alcohol screening for driver applicants, as part of periodic DOT-required physical examinations, and for probable suspicion or cause, deserves consideration. Furthermore, a DOT pilot demonstration program with one or more States for random drug testing could provide valuable information on the role of such testing in accident reduction and the acceptability of such a program on a national basis. **Congress may wish to encourage DOT to act on these options.** Since a record of previous violations is characteristic of many truck drivers involved in serious accidents, Congress may wish to monitor DOT's decisions about violations committed during part-time employment or off-duty driving.

The contribution that careful, appropriate training can make to accident reduction has been amply documented by industry. **OTA concludes that training is an area neglected by DOT and that national guidelines for driver training are needed.** (See chapter 4 for policy options that address this issue.)

Considerable public and private effort will be required to make any new safety standards effective. Carrier management commitment to safety and to implementing new standards play pivotal roles. A cooperative government-private sector research and education program is one way to address management issues such as driver hiring, screening, training programs, and scheduling revisions to help accommodate circadian rhythm.

The hours-of-service regulations, do not adequately account for the effects of operating on the Interstate highway system, new vehicle technologies, and advances in understanding of fatigue and sleep needs. **OTA finds compelling reasons for DOT to reexamine the hours-of-service rules and, if warranted, to develop revised standards based on current research results and today's around-the-clock operating environment.** A carefully phased program to address the issue is essential. Cooperative government-industry studies including independent drivers, private carriers, and large and small for-hire carriers to explore feasible scheduling, training, and education programs are important initial steps. **Congress may wish to encourage more DOT research on this issue, to provide funds for the research, and to meet specified deadlines for revised standards.**

OTA concludes that Federal programs are needed to help management and drivers understand when drivers are most vulnerable to accidents and how alterations to scheduling and other procedures could reduce driver vulnerability. Moreover, a research program to develop simple, effective, and inexpensive techniques to screen drivers who may have a sleep disorder could help identify the high-risk driver.

OTA finds that the use of radar detectors by motor carrier and automobile drivers alike promotes speeding and thus increases the likelihood of an accident. Because high speeds are closely tied to accident severity, Congress may wish to consider taking decisive steps at the Federal level to prohibit these devices.

Finally, education programs directed at motor carrier and automobile drivers could enhance awareness of safety issues related to sharing the roads. These programs should focus on the handling and stability characteristics of trucks, the need to maintain adequate distance between vehicles, the longer distances required for a heavy truck to stop, and the severe damage that can result from a collision between cars and trucks. **Congress may wish to require the National Highway Traffic Safety Administration and FHWA to play mutually supportive roles in developing a model program for States to ensure that these messages reach a broad population by being incorporated into the driver license and renewal process.**

Chapter 7

Sources of Information for Evaluating Safety

Photo credit: California Department of Transportation

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Chapter 7

Sources of Information for Evaluating Safety

An essential component of safety measurement and evaluation is a complete and accurate database containing relevant accident and exposure statistics. Such a database permits identifying causal factors contributing to accident frequency and severity, so that programs and priorities for improving safety can be established. No such database exists for motor carriers, although several public and private organizations collect motor vehicle accident data from which information on heavy truck accidents can be derived. In most instances, however, these reporting systems are designed for general traffic and safety analysis, and often do not provide detail on heavy truck accident characteristics.

This chapter describes and evaluates existing sources of information for evaluating safety, including Federal, State, and industry accident, inspection, and exposure data and motor carrier market entry, exit, and financial performance data. Gaps in information are identified, and options are presented for strengthening the validity of truck safety data and eliminating redundant efforts. Many interconnecting issues are pertinent to truck safety, and existing data could be used to meet both national and more focused needs. Accident and exposure data have several potential uses: 1) general level, time-history trend analysis, 2) analyses of the underlying causes and contributing factors of accidents, and 3) evaluation by Federal, State, and individual carrier management of their respective motor carrier safety activities.

FEDERAL ACCIDENT INFORMATION SYSTEMS

Because several Federal agencies have different responsibilities related to transportation safety, many accident databases have been developed. Each has different reporting requirements, and integrating information from the forms is not feasible currently.

Federal Highway Administration

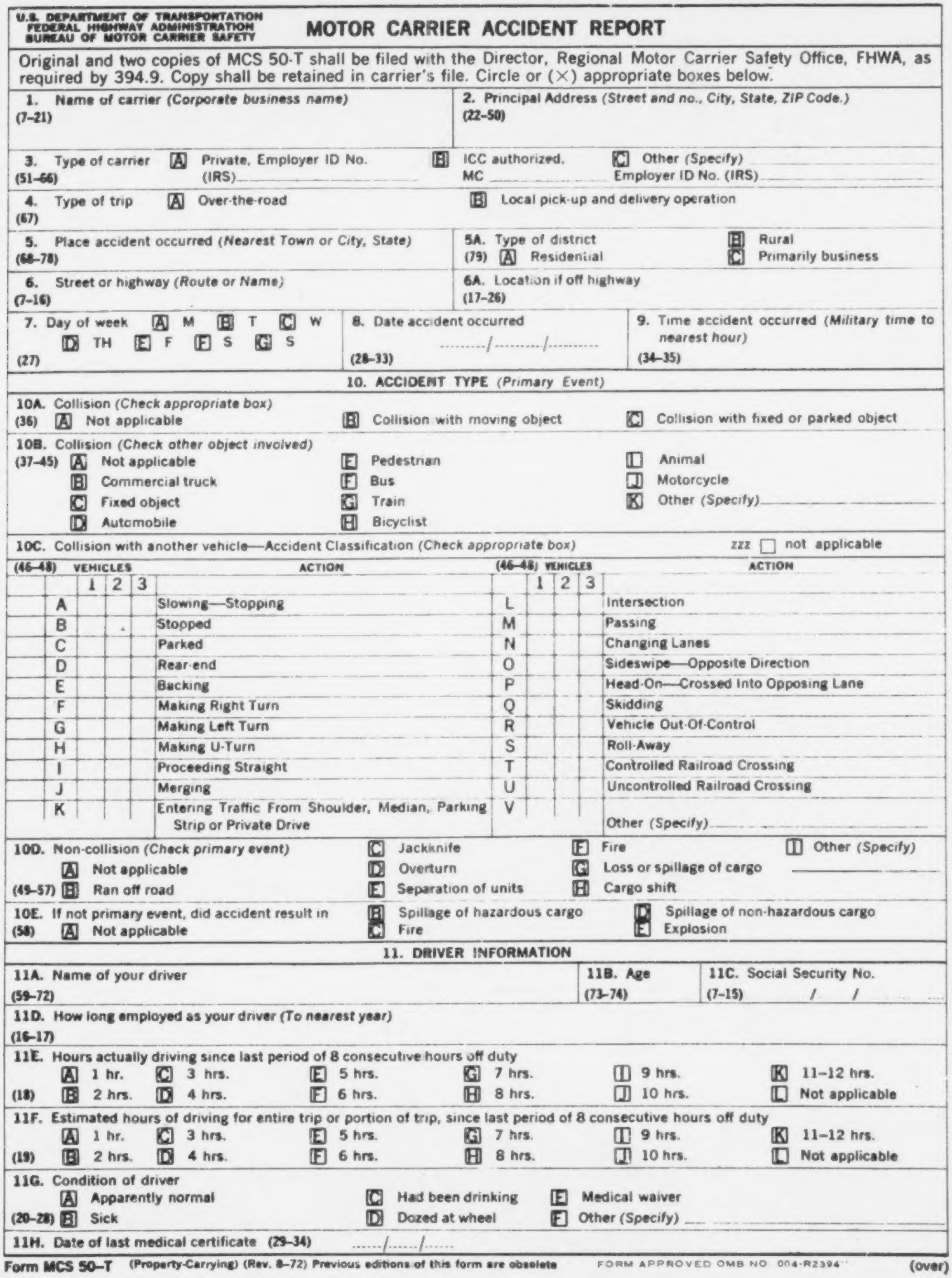
The Office of Motor Carriers of the Federal High way Administration (FHWA) has maintained a motor carrier accident database, the Motor Carrier Management Information System (MCMIS), since 1973. Prior to 1986, interstate carriers regulated by the Federal Government were required to report to MCMIS accidents resulting in a fatality, an injury, or property damage of $2,000 or more. In January 1986, the property damage criteria was increased to $4,200; and effective March 1987, increased again to $4,400. It will continue to increase in accordance with the gross national product deflator index to keep the reporting threshold consistent with inflation.

Accident reports are filed by carriers on Form 50-T (see figure 7-1), in a format that has remained relatively stable through the years. An FHWA analyst corrects erroneous data on the accident reports received and determines whether the accident meets the criteria for a reportable accident. The report is then forwarded to a contractor for input into the computer. During this phase of processing, validation checks are made for data field compatibility and data input errors.

Because of its design, MCMIS provides far more detail on truck accident characteristics than does any other national accident database. It includes carrier identification and address, location of the incident, characteristics of the event, contributing factors, information on the cargo, and consequences of the accident.

However, many operators in the trucking industry, including many private carriers and most intrastate carriers, are not subject to the Federal regulations that require them to report and are

Figure 7-1.—Motor Carrier Accident Report Form—Page One



U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
BUREAU OF MOTOR CARRIER SAFETY

MOTOR CARRIER ACCIDENT REPORT

Original and two copies of MCS 50-T shall be filed with the Director, Regional Motor Carrier Safety Office, FHWA, as required by 394.9. Copy shall be retained in carrier's file. Circle or (×) appropriate boxes below.

1. Name of carrier *(Corporate business name)* **(7–21)**

2. Principal Address *(Street and no., City, State, ZIP Code.)* **(22–50)**

3. Type of carrier **(51–66)** A Private, Employer ID No. (IRS)________ B ICC authorized, MC ________ C Other *(Specify)* ________ Employer ID No. (IRS) ________

4. Type of trip **(67)** A Over-the-road B Local pick-up and delivery operation

5. Place accident occurred *(Nearest Town or City, State)* **(68–78)**

5A. Type of district **(79)** A Residential B Rural C Primarily business

6. Street or highway *(Route or Name)* **(7–16)**

6A. Location if off highway **(17–26)**

7. Day of week **(27)** A M B T C W D TH E F F S G S

8. Date accident occurred **(28–33)** ..../........./.........

9. Time accident occurred *(Military time to nearest hour)* **(34–35)**

10. ACCIDENT TYPE *(Primary Event)*

10A. Collision *(Check appropriate box)*
(36) A Not applicable B Collision with moving object C Collision with fixed or parked object

10B. Collision *(Check other object involved)*
(37–45)
A Not applicable
B Commercial truck
C Fixed object
D Automobile
E Pedestrian
F Bus
G Train
H Bicyclist
I Animal
J Motorcycle
K Other *(Specify)*________

10C. Collision with another vehicle—Accident Classification *(Check appropriate box)* zzz ☐ not applicable

(46–48)	VEHICLES 1	2	3	ACTION	(46–48)	VEHICLES 1	2	3	ACTION
A				Slowing—Stopping	L				Intersection
B				Stopped	M				Passing
C				Parked	N				Changing Lanes
D				Rear-end	O				Sideswipe—Opposite Direction
E				Backing	P				Head-On—Crossed Into Opposing Lane
F				Making Right Turn	Q				Skidding
G				Making Left Turn	R				Vehicle Out-Of-Control
H				Making U-Turn	S				Roll-Away
I				Proceeding Straight	T				Controlled Railroad Crossing
J				Merging	U				Uncontrolled Railroad Crossing
K				Entering Traffic From Shoulder, Median, Parking Strip or Private Drive	V				Other *(Specify)*________

10D. Non-collision *(Check primary event)*
(49–57)
A Not applicable
B Ran off road
C Jackknife
D Overturn
E Separation of units
F Fire
G Loss or spillage of cargo
H Cargo shift
I Other *(Specify)* ________

10E. If not primary event, did accident result in
(58)
A Not applicable
B Spillage of hazardous cargo
C Fire
D Spillage of non-hazardous cargo
E Explosion

11. DRIVER INFORMATION

11A. Name of your driver **(59–72)**

11B. Age **(73–74)**

11C. Social Security No. **(7–15)** / /

11D. How long employed as your driver *(To nearest year)* **(16–17)**

11E. Hours actually driving since last period of 8 consecutive hours off duty
(18)
A 1 hr.
B 2 hrs.
C 3 hrs.
D 4 hrs.
E 5 hrs.
F 6 hrs.
G 7 hrs.
H 8 hrs.
I 9 hrs.
J 10 hrs.
K 11–12 hrs.
L Not applicable

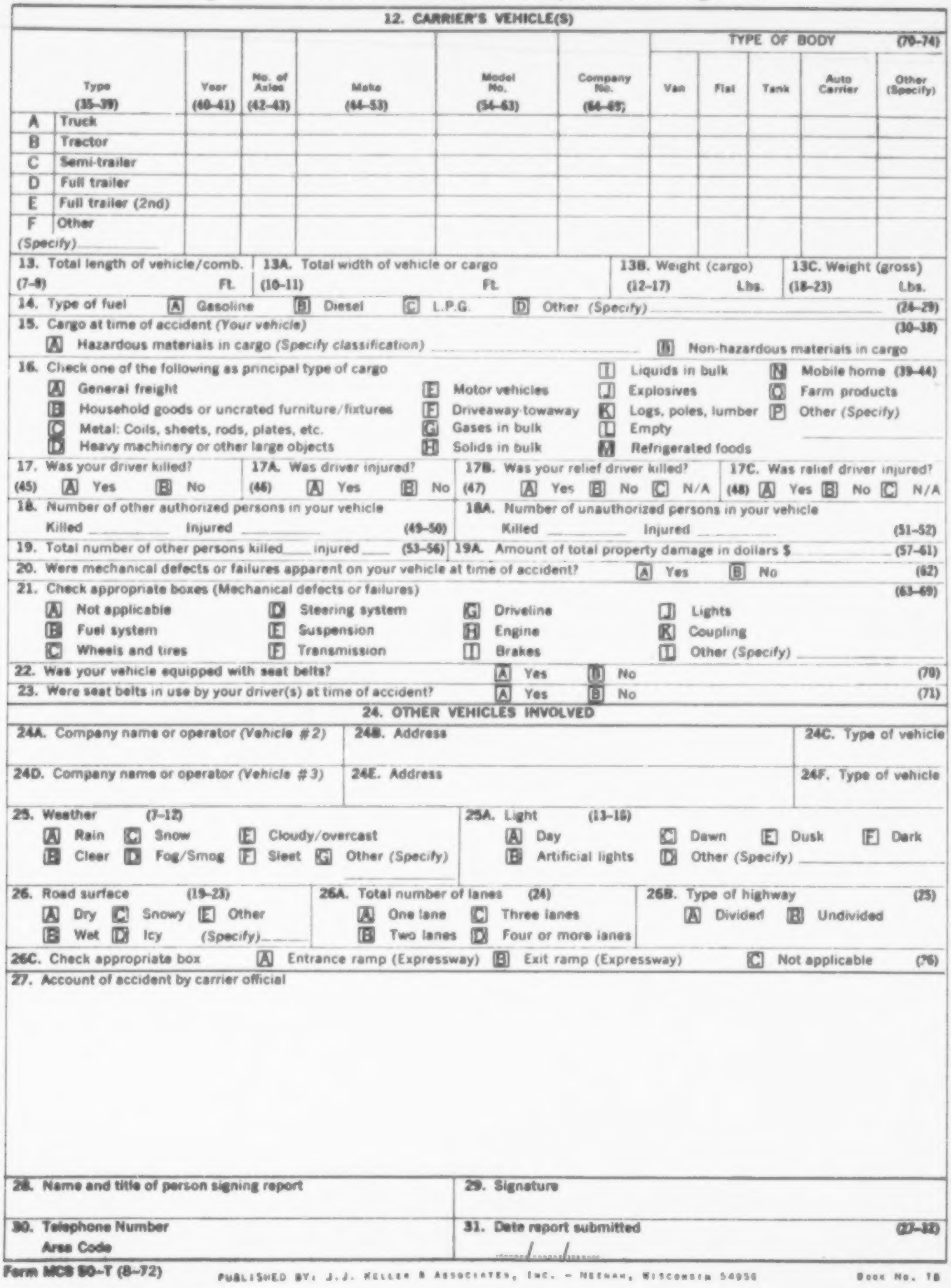
11F. Estimated hours of driving for entire trip or portion of trip, since last period of 8 consecutive hours off duty
(19)
A 1 hr.
B 2 hrs.
C 3 hrs.
D 4 hrs.
E 5 hrs.
F 6 hrs.
G 7 hrs.
H 8 hrs.
I 9 hrs.
J 10 hrs.
K 11–12 hrs.
L Not applicable

11G. Condition of driver
(20–28)
A Apparently normal
B Sick
C Had been drinking
D Dozed at wheel
E Medical waiver
F Other *(Specify)* ________

11H. Date of last medical certificate **(29–34)** ....../....../......

Form MCS 50–T (Property-Carrying) (Rev. 8–72) Previous editions of this form are obsolete FORM APPROVED OMB NO. 004-R2394 (over)

Figure 7-1.—Motor Carrier Accident Report Form—Page Two



12. CARRIER'S VEHICLE(S)

Type (35–39)		Year (40–41)	No. of Axles (42–43)	Make (44–53)	Model No. (54–63)	Company No. (64–69)	TYPE OF BODY (70–74) Van	Flat	Tank	Auto Carrier	Other (Specify)
A	Truck										
B	Tractor										
C	Semi-trailer										
D	Full trailer										
E	Full trailer (2nd)										
F	Other *(Specify)* ______										

13. Total length of vehicle/comb. (7–8) Ft.	13A. Total width of vehicle or cargo (10–11) Ft.	13B. Weight (cargo) (12–17) Lbs.	13C. Weight (gross) (18–23) Lbs.

14. Type of fuel [A] Gasoline [B] Diesel [C] L.P.G. [D] Other *(Specify)* ______ (24–29)

15. Cargo at time of accident *(Your vehicle)* (30–38)
[A] Hazardous materials in cargo *(Specify classification)* ______ [B] Non-hazardous materials in cargo

16. Check one of the following as principal type of cargo (39–44)
[A] General freight
[B] Household goods or uncrated furniture/fixtures
[C] Metal: Coils, sheets, rods, plates, etc.
[D] Heavy machinery or other large objects
[E] Motor vehicles
[F] Driveaway-towaway
[G] Gases in bulk
[H] Solids in bulk
[I] Liquids in bulk
[J] Explosives
[K] Logs, poles, lumber
[L] Empty
[M] Refrigerated foods
[N] Mobile home
[O] Farm products
[P] Other *(Specify)* ______

17. Was your driver killed? (45) [A] Yes [B] No
17A. Was driver injured? (46) [A] Yes [B] No
17B. Was your relief driver killed? (47) [A] Yes [B] No [C] N/A
17C. Was relief driver injured? (48) [A] Yes [B] No [C] N/A

18. Number of other authorized persons in your vehicle Killed ______ Injured ______ (49–50)
18A. Number of unauthorized persons in your vehicle Killed ______ Injured ______ (51–52)

19. Total number of other persons killed ____ injured ____ (53–56)
19A. Amount of total property damage in dollars $ ______ (57–61)

20. Were mechanical defects or failures apparent on your vehicle at time of accident? [A] Yes [B] No (62)

21. Check appropriate boxes (Mechanical defects or failures) (63–69)
[A] Not applicable
[B] Fuel system
[C] Wheels and tires
[D] Steering system
[E] Suspension
[F] Transmission
[G] Driveline
[H] Engine
[I] Brakes
[J] Lights
[K] Coupling
[L] Other *(Specify)* ______

22. Was your vehicle equipped with seat belts? [A] Yes [B] No (70)

23. Were seat belts in use by your driver(s) at time of accident? [A] Yes [B] No (71)

24. OTHER VEHICLES INVOLVED

24A. Company name or operator *(Vehicle #2)*	24B. Address	24C. Type of vehicle
24D. Company name or operator *(Vehicle #3)*	24E. Address	24F. Type of vehicle

25. Weather (7–12) [A] Rain [B] Clear [C] Snow [D] Fog/Smog [E] Cloudy/overcast [F] Sleet [G] Other *(Specify)*

25A. Light (13–18) [A] Day [B] Artificial lights [C] Dawn [D] Other *(Specify)* ______ [E] Dusk [F] Dark

26. Road surface (19–23) [A] Dry [B] Wet [C] Snowy [D] Icy [E] Other *(Specify)* ____

26A. Total number of lanes (24) [A] One lane [B] Two lanes [C] Three lanes [D] Four or more lanes

26B. Type of highway (25) [A] Divided [B] Undivided

26C. Check appropriate box [A] Entrance ramp (Expressway) [B] Exit ramp (Expressway) [C] Not applicable (26)

27. Account of accident by carrier official

28. Name and title of person signing report

29. Signature

30. Telephone Number
Area Code

31. Date report submitted (27–32)
____/____/____

Form MCS 50–T (8–72) PUBLISHED BY: J.J. KELLER & ASSOCIATES, INC. – NEENAH, WISCONSIN 54956 Book No. 18

SOURCE: Federal Highway Administration.

therefore not represented in the accident statistics. Furthermore, the accuracy and completeness of the accident reports to MCMIS are open to question, given Federal reliance on carriers to file reports and minimal attempts by FHWA to ensure reporting compliance. FHWA officials have publicly acknowledged that underreporting of accidents may be as high as 40 percent, and they look to the full implementation of SAFETYNET[1] and eventual completion of safety fitness ratings for all interstate carriers as remedies.[2]

A more recent initiative, started in 1983, is a special monitoring study under which FHWA has enlisted several States to collect data on accidents and exposure for all combination trucks operating on the designated Interstate and Federal-aid highway truck network. The goal is to acquire data for making comparisons between accidents among various truck types and across different road features. Under the program, State highway agencies report accident and exposure data to FHWA every 6 months. Data elements include vehicle-miles traveled by route, number of trailers and axles, accident involvement by vehicles involved, injuries and fatalities, width and type of lanes, shoulders and medians, degree of access control, and road curvature and grade.[3]

This approach represents a reasonable attempt to collect accident and exposure measures from the same population. However, the study is limited both by the relatively small number of participating States and by the accuracy of information provided, particularly the completeness with which truck characteristics are reported and the ways exposure data are estimated.

Currently being developed for FHWA is the Commercial Driver's License Information System. This system will eventually provide FHWA with information on persons holding commercial driver's licenses and will be tied to State systems like SAFETYNET.

National Highway Traffic Safety Administration

The National Center for Statistics and Analysis of the National Highway Traffic Safety Administration (NHTSA) maintains accident data on police-reported accidents, including those resulting in nonfatal injury and/or property damage. Initiated in 1979, the National Accident Sampling System (NASS) is a file of reported accidents that provides an automated, comprehensive, national traffic accident database. The accidents investigated in NASS are a probability sample of police-reported accidents in the United States; the investigations are carried out by NHTSA contractors. These data are subsequently weighted to represent all police-reported motor vehicle accidents occurring in the Nation during the year. To be included in NASS, an accident must: 1) be reported by police, 2) result in property damage and/or personal injury, and 3) involve a motor vehicle in transport on a roadway.[4] A NASS investigation is handled by field staff that examines the vehicle and scene, interviews vehicle occupants, and reviews medical and driver records. Approximately 12,000 cases are investigated each year by 50 teams.

The data collected for a NASS-investigated accident include over 300 variables describing characteristics of the accident, driver, occupants, and the vehicle. For heavy truck accidents, several data fields exist that describe truck operations in reasonable detail. They include carrier type; number of trailers and axles; body type; extent of Interstate Commerce Commission (ICC) regulation; type of brakes and cab configuration; cargo weight; gross vehicle weight; hazardous cargo; vehicle length and width; and jackknife, underride/override, or rollover involvement.

Although NASS has several strengths, such as sampling design and comprehensiveness of the accident investigation, one major deficiency is the relatively small number of heavy truck accidents that constitute the NASS sample in a given year. As a result, questions may be raised about the representativeness of the NASS sample for a single year in evaluating national issues involving heavy truck safety, particularly issues that are narrowly focused and require considerable detail.

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[1] A comprehensive nationwide enforcement data system that will aid State inspection activities and provide additional accident and safety data.

[2] John MacGowan, U.S. Department of Transportation, Federal Highway Administration, personal communication, Oct. 17, 1986. Problems with reporting accuracy in transportation accident information systems are common, as noted in U.S. Congress, Office of Technology Assessment, *Transportation of Hazardous Materials*, OTA-SET-304 (Washington, DC: U.S. Government Printing Office, July 1986).

[3] Director, Federal Highway Administration, Office of Highway Information Management, "Monitoring Operations of Larger Dimensioned Vehicles," memo to Regional Federal Highway Administrators, Apr. 23, 1986.

[4] National Highway Traffic Safety Administration, *National Accident Sampling System (NASS): Analytical User's Manual* (Washington, DC: U.S. Department of Transportation, 1985).

This problem may be further compounded by planned changes in the NASS data collection program. In 1988, two separate data collection systems will be implemented: 1) the Crashworthiness Data System (CDS), and 2) the General Estimates System (GES). CDS will include the more thorough accident investigation described previously, but it will be limited principally to accidents involving cars, light trucks, and vans towed from the accident scene. GES will provide national estimates of accident trends from sampled police reports, using a larger accident sample than in the past and will include all vehicle types. The new approach will meet NHTSA's objectives of preserving crashworthiness information for the vehicles that are most numerous on the highway, while reducing data collection costs. It will also portray more accurately annual trends in the number and severity of accidents involving heavy trucks, but will reduce the ability to conduct detailed analyses of motor carrier safety issues.

Accidents that result in the loss of human life are also classified separately in the Fatal Accident Reporting System (FARS), which has been in operation since 1975. FARS contains over 90 variables for describing accidents in which an accident-related death occurs within 30 days of the accident.[5] FARS is not a national sample; rather, it is a census of all fatal traffic accidents reported in the United States. This information is collected by each State, under contract to NHTSA. While FARS is generally accepted as the most complete database for fatal accidents, it is limited to this one category of accidents. Furthermore, because the investigation is not as extensive as that for NASS observations, details on truck operation and motor carrier type are not available.[6] For example, FARS distinguishes only between straight trucks and combinations, and only among several broad weight classes.[7] Details about accidents involving the trucks described in box 7-A could not be extracted, for example.

National Transportation Safety Board

The National Transportation Safety Board (NTSB) conducts multimodal, on-scene investigations of transportation accidents. NTSB's jurisdiction for conducting an investigation is based on the definition of a major vehicular accident for each mode, as described in the Code of Federal Regulations, Part 49.

An NTSB investigation begins with a multiple-day field investigation involving the shipper, carrier, government agencies, associations, and other interested parties. Its subsequent report goes through several cycles of review and comment before it is final. A major advantage of the NTSB process is that the investigations involve other participants besides the carrier, are extremely thorough, and take place over a longer time frame so that the full impact of the accident can be more accurately identified. Because of the resources required to conduct such a thorough investigation, the number of accidents that are examined is relatively small and findings often cannot be generalized to the national population.

Recently, NTSB has embarked on an extended special study of heavy truck safety.[8] The study covers a minimum of 200 accidents involving heavy trucks that meet the following criteria: 1) the accident involves a truck of greater than 10,000 pound gross vehicle weight rating, and 2) the truck receives damage sufficient to require towing away from the scene. NTSB plans to document thoroughly the accident characteristics related to the driver, vehicle, roadway, and motor carrier. This will provide valuable information. However, the NTSB special study will include a static file of 200 cases rather than a continuous database.

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[5] National Highway Traffic Safety Administration, *Fatal Accident Reporting System: 1986 Coding and Validation Manual* (Washington, DC: U.S. Department of Transportation, 1986).

[6] Joel Dandrea, *Truck Accident and Exposure Data* (Washington, DC: American Trucking Associations, June 1986).

[7] National Academy of Sciences, Transportation Research Board, *Truck Accident Data Systems: State-of-the-Art Report*, Transportation Research Circular 231, ISSN 0097-8515 (Washington, DC: September 1981).

[8] National Transportation Safety Board, "NTSB Heavy Truck Study: Status Report of NTSB Cases," presented at the National Motor Carrier Safety Workshop, Washington, DC, Mar. 11, 1987.

Box 7-A.—Hot Shot Trucks

Hot Shot Trucks are relatively new phenomena, appearing over the past 5 years as large freight vehicles.[1] Hybrid trucks that do not fit within standard industry classifications, Hot Shots are often modified pickup trucks pulling 48-foot trailers. While heavier trucks are increasingly being built to serve as Hot Shots, some weighing as much as 26,000 pounds, no average weight has been established. They are used to haul light-weight freight, such as insulation, plastic piping, or construction materials.

Economics are the major attraction for these vehicles. A Class 8 tractor-trailer purchased for $100,000 may require $1 a mile to move the same load that a Hot Shot, initially costing $50,000 or less, can move for 35 cents. Hot Shots offer the advantages of weights that allow them to avoid Federal Highway Use taxes levied on trucks with taxible gross weights over 55,000 pounds and truck tractor Chassis Excise tax imposed at the time of first retail purchase on vehicles over 33,000 pounds gross vehicle weight rating.[2]

While no reliable numbers exist on how many of these vehicles are on the roads, experts estimate that they currently number less than 10,000. Sales of Hot Shots are projected to increase 125 percent over the next 5 years.

Because no type of classification exists for these vehicles, no industry or Federal safety standards have been established. Hot Shots have lower centers of gravity than standard tractors, and observers have noted more complete air brake systems, diesel engines, and sturdier suspension systems in recent purchases. Because the trucks do not fall into readily recognizable categories, accident report forms do not have identifying classes for them. Consequently, accumulating data on how many accidents Hot Shots are involved in and how many miles they are driven is next to impossible.

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[1] Henry Seiff, Motor Vehicle Manufacturer's Association and William Snow, National Highway Traffic Safety Administration, personal communications, July 22, 1988.

[2] Brady Collins, American Trucking Associations, personal communication, Aug. 10, 1988.

State Databases

State accident data generally do not use a common threshold for reporting and therefore do not easily lend themselves to aggregation on a national basis.[9] However, because many State reports include more detail on certain types of accidents, analysis of State accident data is extremely useful. Furthermore, as a significant proportion of heavy truck accidents occur in the several large States that have considerable heavy truck populations, analyses of accident data from these States are probably representative of the characteristics of most heavy truck accidents. Finally, because State accident files include reports on accidents of varying injury severity, the full range of accident consequences may be examined.

A limitation of State databases is that they are gathered from police reports, which in turn depend partly on drivers' statements. Drivers may not know the answers to some specific questions or may be reluctant to admit violations or noncompliance with regulations.[10] Furthermore, police have important responsibilities on the scene related to administering emergency first-aid and maintaining traffic flow, often making it difficult to be thorough when completing accident reports. Moreover, few enforcement officers are well trained in accident investigations.

NHTSA maintains a directory of State accident reporting systems.[11] State reporting systems show wide variation in accident reporting thresholds, reporting variables, and definition of variable fields, particularly for items related to heavy truck safety analysis, where detail on truck configuration and use is essential.

To create some consistency in accident reporting at the State level for crash avoidance research purposes, NHTSA developed the Crash Avoidance Research Datafile (CARDfile). It consists of automated police accident reports of six States (Indiana, Maryland, Michigan, Pennsylvania, Texas, and Washington). All data contained in CARDfile have been coded in a common format, regardless of the particular format employed by the State from which the information originated.[12] The file contains information on accident, vehicle, and driver characteristics. However, because States do not yet use common data elements and include limited information about truck configuration and operations, analysis that can be based on CARDfile is limited.

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[9] National Academy of Sciences, op. cit., footnote 7, p. 3.

[10] Ibid.

[11] National Highway Traffic Safety Administration, *State Accident Report Forms Catalog 1985*, DOT HS 806 884 (Washington, DC: U.S. Department of Transportation, 1986).

The Commercial Vehicle Safety Alliance (CVSA) is working to establish uniform accident reporting through the design of a report form that includes standard variables and variable fields that all States would use.[13] (See figure 7-2.) This has proven to be difficult, since each State has different means of collecting accident data, different agencies charged with collecting data, and different forms on which the information is reported. Nonetheless, CVSA anticipates that agreement can be reached on data items that focus on issues of major concern.[14]

The National Governors' Association is also developing recommendations and guidelines for States to adopt for uniform reporting of heavy truck accidents. Their focus includes both reporting criteria and data elements for the accident report form. A preliminary list of 19 data elements has been proposed, covering driver, carrier, vehicle, accident, highway, and environmental characteristics, as well as any hazardous cargo. A survey of existing State accident reporting systems revealed that for *every* State in the Nation, the *majority* of data elements are either not presently collected or are not currently collected as prescribed.[15]

Industry Sources

Many medium and large carriers maintain detailed records of their drivers and vehicles that permit the identification of characteristics affecting truck safety. Carrier accident data has several advantages over public domain databases, particularly because it allows analysis of accidents over time and provides consistent exposure data for determining accident rates. Also, some issues, such as driver hours-of-service and training, are likely to be more accessible and accurate in the carrier database.

However, carrier concerns about confidentiality must be respected, and generalizing the results of such studies to the trucking industry nationwide is risky. Analysis of an individual carrier represents a single data point within the industry.

Trade associations, such as the American Trucking Associations and the Private Truck Council of America, periodically collect accident rate statistics from their member carriers. However, this information is reported only as an aggregate rate for the industry (and carrier type), and no information is available for examining an individual accident, its contributing factors, or its severity.

Other Relevant Databases

Insurance companies that underwrite motor carriers maintain detailed financial and statistical data on insurance policies and claims. Much of this information is also transmitted in aggregate form to the Insurance Services Offices, Inc. (ISO), a nonprofit corporation that makes available advisory rating, statistical, actuarial, policy form, and related services to U.S. property/casualty insurers.[16] The statistical data collected by ISO are quite detailed and permit the investigation of several industry characteristics, such as driver age, vehicle age, size of claim, geographic location, vehicle weight, and zone rating (distance-based). The primary statistic used for safety analysis is a loss ratio.[17] However, because information is reported in aggregate form to ISO, and the insurance industry is interested in financial performance rather than accident causes, this database does not provide useful information for safety analyses.

The University of Michigan Transportation Research Institute

The University of Michigan Transportation Research Institute (UMTRI) has developed a database

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[12] National Highway Traffic Safety Administration, *File Structure: Crash Avoidance Research Datafile* (Washington, DC: U.S. Department of Transportation, May 29, 1986).

[13] At a minimum, this would include common use of essential data fields, with each State having the latitude to retain additional data fields for its own use. For further information on the Commercial Vehicle Safety Alliance, see ch. 3.

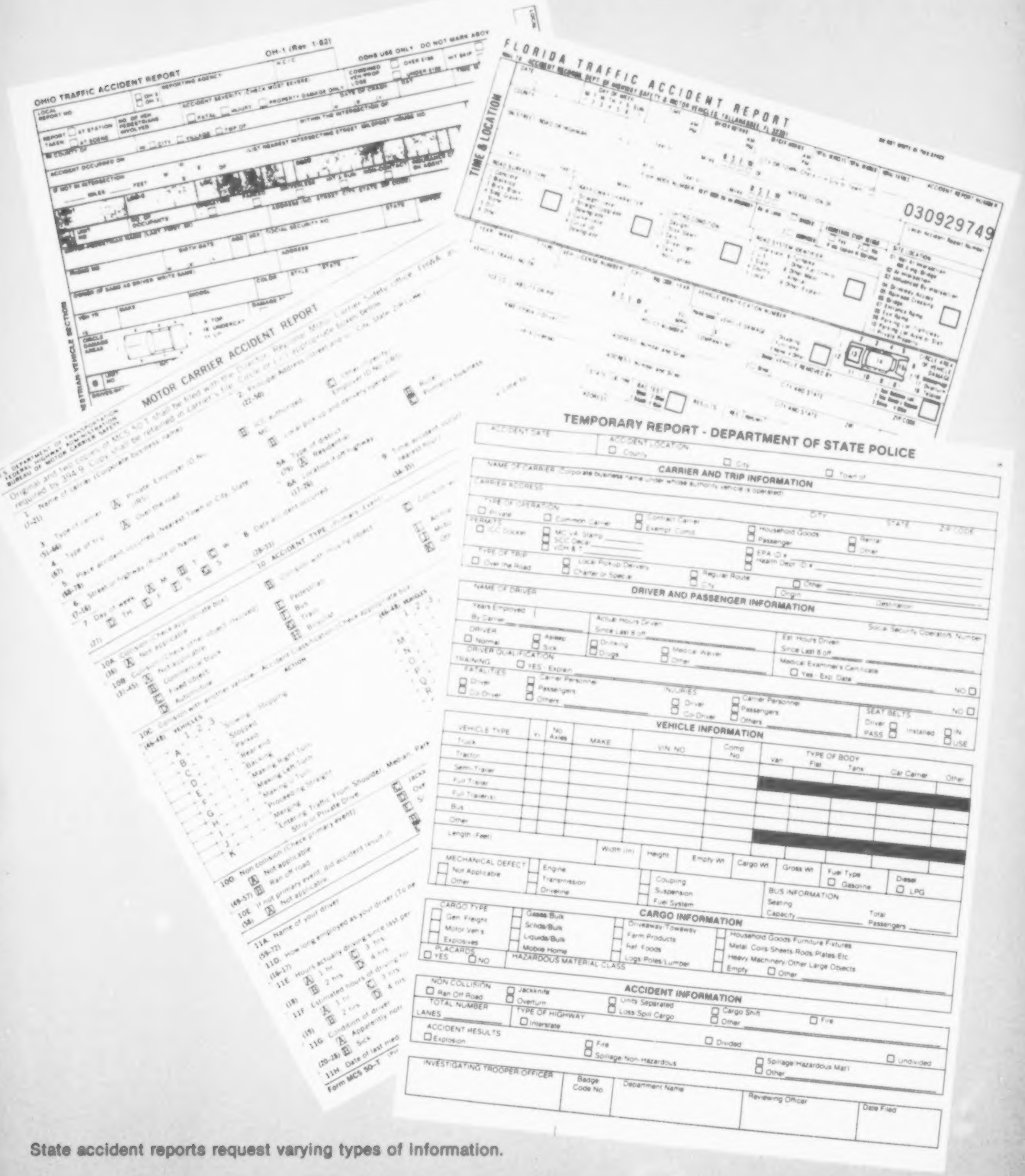
[14] Rick Owens, chairman, Commercial Vehicle Safety Alliance Data Collection Committee, memo to committee members, Sept. 12, 1986.

[15] National Governors' Association, Center for Policy Research, "Report 2 of the Motor Carrier Accident Reporting Committee," unpublished manuscript, January 1988.

[16] Not all U.S. insurers recognize and participate in Insurance Services Office, Inc. data collection.

[17] Ann Lavie, Insurance Services Office, Inc., personal communication, Apr. 10, 1987.

Figure 7-2.—A Sample of State Accident Report Forms



OHIO TRAFFIC ACCIDENT REPORT

OH-1 (Rev. 1-83)

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
BUREAU OF MOTOR CARRIER SAFETY

MOTOR CARRIER ACCIDENT REPORT

Form MCS 50-T

FLORIDA TRAFFIC ACCIDENT REPORT

TIME & LOCATION

030929749

TEMPORARY REPORT - DEPARTMENT OF STATE POLICE

ACCIDENT DATE

ACCIDENT LOCATION ☐ County ☐ City ☐ Town of

CARRIER AND TRIP INFORMATION

NAME OF CARRIER (Corporate business name under whose authority vehicle is operated)

CARRIER ADDRESS

CITY STATE ZIP CODE

TYPE OF OPERATION ☐ Private ☐ Common Carrier ☐ Contract Carrier ☐ Exempt Comd

PERMITS ☐ ICC Docket ☐ MC VA Stamp ☐ SCC Decal ☐ VDH & T ☐ Household Goods ☐ Passenger ☐ Rental ☐ Other ☐ EPA ID # ☐ Health Dept. ID #

TYPE OF TRIP ☐ Over the Road ☐ Local Pickup Delivery ☐ Charter or Special ☐ Regular Route ☐ City ☐ Other

Origin Destination

DRIVER AND PASSENGER INFORMATION

NAME OF DRIVER

Years Employed By Carrier

Actual Hours Driven Since Last 8 off

Social Security Operator's Number

DRIVER ☐ Normal ☐ Asleep ☐ Sick ☐ Drinking ☐ Drugs ☐ Medical Waiver ☐ Other

Est. Hours Driven Since Last 8 off

DRIVER QUALIFICATION

TRAINING ☐ YES - Explain

Medical Examiner's Certificate ☐ Yes - Exp. Date NO ☐

FATALITIES ☐ Driver ☐ Co-Driver ☐ Carrier Personnel ☐ Passengers ☐ Others

INJURIES ☐ Driver ☐ Co-Driver ☐ Carrier Personnel ☐ Passengers ☐ Others

SEAT BELTS Driver ☐ PASS ☐ Installed ☐ IN ☐ USE NO ☐

VEHICLE INFORMATION

VEHICLE TYPE	Yr	No. Axles	MAKE	VIN NO	Comp No	TYPE OF BODY Van	Flat	Tank	Car Carrier	Other
Truck										
Tractor										
Semi-Trailer										
Full Trailer										
Full Trailer(s)										
Bus										
Other										
Length (Feet)										

Width (in) Height Empty Wt Cargo Wt Gross Wt Fuel Type ☐ Gasoline Diesel ☐ LPG

MECHANICAL DEFECT ☐ Not Applicable ☐ Other ☐ Engine ☐ Transmission ☐ Driveline ☐ Coupling ☐ Suspension ☐ Fuel System

BUS INFORMATION Seating Capacity Total Passengers

CARGO INFORMATION

CARGO TYPE ☐ Gen. Freight ☐ Motor Veh's ☐ Explosives ☐ Gases/Bulk ☐ Solids/Bulk ☐ Liquids/Bulk ☐ Mobile Home ☐ Driveaway/Towaway ☐ Farm Products ☐ Ref. Foods ☐ Logs/Poles/Lumber ☐ Household Goods/Furniture Fixtures ☐ Metal: Coils/Sheets/Rods/Plates/Etc ☐ Heavy Machinery/Other Large Objects ☐ Empty ☐ Other

PLACARDS ☐ YES ☐ NO HAZARDOUS MATERIAL CLASS

ACCIDENT INFORMATION

NON COLLISION ☐ Ran Off Road ☐ Jackknife ☐ Overturn ☐ Units Separated ☐ Loss/Spill Cargo ☐ Cargo Shift ☐ Other ☐ Fire

TOTAL NUMBER LANES

TYPE OF HIGHWAY ☐ Interstate ☐ Divided ☐ Undivided

ACCIDENT RESULTS ☐ Explosion ☐ Fire ☐ Spillage/Non-Hazardous ☐ Spillage/Hazardous Mat'l ☐ Other

INVESTIGATING TROOPER/OFFICER	Badge Code No.	Department Name	Reviewing Officer	Date Filed

State accident reports request varying types of information.

that combines the coverage of FARS with the detail of the FHWA motor carrier accident database. All heavy truck accidents in the FARS database (beginning with 1980) are identified and the records matched with the FHWA records for accidents in which a fatality occurred. Police reports of the accidents are reviewed and a single accident record created that includes information from all sources.[18] Because of different definitions of industry coverage and missing items in many FARS reports, a considerable amount of post-accident investigation has been undertaken by UMTRI to complete the information in the database. Followup investigation is handled primarily through telephone conversations with owners of the involved trucks, a painstaking and labor-intensive process.

All of the FHWA data and most of the post-accident information depends on the accuracy of the responses provided by the owners. Furthermore, the UMTRI database includes only accidents involving a fatality—less than 2 percent of the overall roadway accidents involving heavy trucks. Thus, while this database represents the most severe occurrences, it may produce findings unrepresentative of most truck accidents occurring in the United States.[19] (See table 7-1 for a summary of accident reporting databases.)

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[18] University of Michigan Transportation Research Institute, *Trucks Involved in Fatal Accidents, 1983*, UMTRI-86-24 (Ann Arbor: University of Michigan, May 1984).

[19] Federal Highway Administration, *Development of a Large Truck Safety Data Needs Study Plan* (Washington, DC: U.S. Department of Transportation, February 1986).

EXPOSURE DATA

To address the truck safety question comprehensively, it is important to derive estimates of both accidents and exposure. Exposure data serve as a denominator in establishing accident rates, and are necessary for determining whether increases in accidents are due to a deterioration in safety practices or an increase in the amount and type of truck travel.

Compared with other freight modes, trucking has the poorest available shipment data. Two principal databases are available publicly for analyzing trucking sector flows: the Truck Inventory and Use Survey (TIUS) and the Commodity Transportation Survey (CTS). Neither presents a complete picture of the trucking sector. These databases and other sources of exposure information are described in this section.

Photo credit: Michael Hines, OTA Staff

Exposure data are essential for interpreting and understanding highway accident statistics.

Truck Inventory and Use Survey

The TIUS has been conducted roughly every 5 years by the Bureau of the Census as part of the census of transportation. It includes sample data on the physical characteristics and operational use of commercial and private trucks in the United States, but does not show year-to-year changes or trends. The 1982 TIUS contains data on the character and use of slightly over 120,000 trucks (including light trucks, pickups, and vans), drawn from an estimated total of 33.8 million. The sampling rate is skewed toward large trucks (approximately 5.6 million vehicles) to enhance that portion of the data, but the sample size is still quite small. Among the specific items contained in the TIUS are vehicle identification number, operator class, range of operation, vehicle design characteristics, annual mileage, and commodities carried.

The TIUS provides a global assessment of both the number of trucks in use and the mileage they

Table 7-1.—Truck Safety Information Resources (Accident Data)

Database	Kept by	Years	Strengths	Weaknesses
50-T (part of MCMIS)	FHWA, Office of Motor Carriers	1973 to present	• Good detail on truck accident characteristics • Exclusive truck focus	• Missing several portions of the truck population • Accuracy and completeness of reports not consistent • Relies on carrier participation
FHWA, Special Monitoring Study	FHWA, Office of Highway Information	1983 to present	• Involves accident and exposure data • Exclusive truck focus	• Restricted to aggregate accident reporting • Limited number of participating States • Missing some truck detail
NASS	NHTSA, National Center for Statistics and Analysis	1979 to present	• Statistical sampling design • Comprehensiveness of accident investigation • Reasonably good detail on truck accident characteristics • National estimates of accident frequency	• Small number of heavy truck accidents in database • Detailed causal analysis sometimes difficult
FARS	NHTSA, National Center for Statistics and Analysis	1975 to present	• Census of all fatal accidents • Comprehensiveness of accident investigation	• Limited details on truck configuration and operation • Nonfatal accidents not represented
NTSB	NTSB	1986 to 1987, single collection	• Comprehensiveness of accident investigation • Good detail on truck characteristics • Exclusive truck focus	• Limited sample of accidents under investigation, not representative of truck crashes generally
State databases	Various State regulatory agencies		• Census of all accident types	• Based solely on police reports at scene • Varying detail on truck accident characteristics • Lack of uniformity from State to State
CARDfile	NHTSA	1982 to present	• Census from several States • Uniformity in reporting format	• Limited truck detail due, in part, to limited uniform variables listed • Based solely on police reports at scene • Limited to a few States
Motor carrier industry	Individual carriers, trade associations		• Some individual carriers maintain excellent detail on accidents and movements • Exclusive truck focus	• Individual carrier represents single observation in industry • Access to individual carrier records is not in the public domain • Trade associations report accident rates but not details on accident characteristics
Insurance companies	Individual companies, ISO		• Detailed financial and statistical data on truck insurance policies and claims	• Aggregate reporting of information by insurers • Primary concern over loss ratio rather than accident causation
UMTRI	UMTRI	1980 to present	• Combines coverage of FARS with detail of 50-T • Post-accident investigation to complete missing information • Exclusive truck focus	• Reliance on information provided by carrier during post-accident investigation • Restricted to fatal accidents

KEY: MCMIS = Motor Carrier Management Information System.
FHWA = Federal Highway Administration.
NASS = National Accident Sampling System.
FARS = Fatal Accident Reporting System.
CARDfile = Crash Avoidance Research Datafile.
NTSB = National Transportation Safety Board.
NHTSA = National Highway Traffic Safety Administration.
ISO = Insurance Services Offices, Inc.
UMTRI = University of Michigan Transportation Research Institute.

SOURCE: Office of Technology Assessment, 1988.

accumulate, but lacks any origin-to-destination flow information or precise definition of commodities. The TIUS is based on voluntary responses from the owners of the vehicles selected; a 90 percent response rate has been achieved in the past. Since the TIUS focuses on aggregate activity based on typical yearly vehicle use, it does not provide information about the driver, vehicle cargo weight, number of trailers, road class, and time of day. The TIUS can be a useful source for static data, such as model year and size of carrier operation. Results from the TIUS now under way are projected to be ready in summer 1989.[20]

Commodity Transportation Survey

The CTS was collected by the Bureau of the Census in approximately 5-year intervals starting in 1963. It contains flow data for commodities shipped by manufacturing establishments selected from several hundred industries. Each record lists the total tons shipped from a given origin to a given destination for a specific commodity, mode of transport, weight, and value. The data are based on voluntary responses from approximately 16,000 establishments to which survey forms are sent. Data are checked against the Census of Manufacturers Survey using the value of shipment information to ensure that the expanded value of shipments made corresponds closely to the value of commodities produced.[21]

While the census' main strength is its multimodal nature, it has real limitations. Shipment data on waste materials, agricultural products, and raw materials are not reported. The CTS also reflects shipments only from point of manufacture to first destination (which many analysts claim is typically a warehouse), missing all subsequent movements in the distribution chain. Data submission is voluntary, creating unknown biases due to nonreporting. Furthermore, the scope of the survey is heavily dependent on Federal budget decisions, and the questions asked are not consistent between surveys, making trend analyses on some issues difficult. Finally, the data are released only at the State-to-State or production area-to-production area level; the Bureau omits any flows that would compromise the confidentiality of the survey's respondents.

Motor Carrier Census File

As part of its MCMIS, FHWA maintains the Motor Carrier Census File. This database contains a basic description of each commercial motor carrier and/or shipper known to FHWA. The unique number assigned to each carrier is included in all forms and records used in the MCMIS.

While this database is used primarily to monitor carrier safety and identify problem motor carriers, it could be used to develop measures of carrier activity and travel pattern indicators. The database contains information on each carrier's State base of operations; States served; type of commodities carried; carrier classification; miles operated; number of drivers; and number of trucks, truck tractors, and trailers, segmented by type of ownership. Unfortunately, the database is incomplete, owing to the many carriers FHWA has yet to evaluate and locate, as well as to those carriers that are not presently subject to Federal motor carrier safety regulations and FHWA oversight.

Highway Performance Monitoring System

The Highway Performance Monitoring System (HPMS) is a combined effort of Federal, State, and local governments to collect national data that provide current statistics on the mileage and characteristics of various highway systems. The annual database is derived from general statistics provided by States for their total system and from more detailed data for a prescribed sample of their highway systems. The sample sections were established using a statistically-designed sampling plan. The plan was based on the random selection of road sections within predetermined average, annual, daily traffic volume groups for each functional highway classification.[22]

The primary purpose of this database is to obtain very specific highway and traffic data for a sample of different highway types. Although area-wide vehicle classification data are reported by the number of axles of single-unit, single-trailer, and multiple-combination vehicles, other vehicle characteristics are not reported. The estimates of truck volumes for these categories are sometimes less accurate for lower functional highway classifications.[23]

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[20] Robert Crowther, Bureau of the Census, Business Division, personal communication, Aug. 9, 1988.

[21] Bureau of the Census, *Commodity Transportation Survey: Summary*, TC77-CS (Washington, DC: U.S. Government Printing Office, June 1981).

[22] Federal Highway Administration, *Highway Performance Monitoring System Field Manual* (Washington, DC: U.S. Department of Transportation, January 1984).

Truck Weight Study

The Truck Weight Study (TWS) is compiled annually by FHWA from information collected voluntarily by the States. It is composed of vehicle classifications and truck weight data, which are collected at preselected sites where such operations can be accommodated. Each State has between 10 and 20 sites, and locations remain relatively constant from year to year. In total, more than 10 million vehicles are classified, and more than 200,000 trucks are weighed on an annual basis.

Classification counts are conducted for three 8-hour shifts that cover all hours of the day, but are not necessarily consecutive. At each location, all of the vehicles in the traffic stream are counted and classified. Several truck types are included, and for each type, the number of axles and axle configurations are recorded. Weighing operations are a separate activity that occur immediately upstream or downstream from the point of classification. Each surveyed vehicle is described by vehicle type, body style, fuel type, class of operation, loaded status, commodity carried, and axle spacing. In those States using weigh-in-motion equipment, survey data are limited to axle spacing and weights, vehicle type, and body type; however, a census of trucks is not always taken, particularly at high-volume locations. In these cases, the more frequently occurring truck types are weighed during one or more 10- to 15-minute intervals in an hour. Less common types are fully sampled.[24]

ALL BUSES
STOP
AT SCALES

Photo credit: California Department of Transportation

Data on vehicle weights are often based on statistics from unsophisticated and temporary State weigh stations.

The main deficiency of the TWS for exposure analysis in the past has been that the counting sites are not statistically representative of the States' highway systems and cannot be used to estimate vehicle-miles traveled by vehicle type. Also the collection stations tend to be oriented toward the Interstate and rural primary systems. Furthermore, many trucks operating in violation of weight standards travel on circuitous routes to avoid weigh stations. FHWA is currently investigating ways to address these concerns and to establish a data collection scheme consistent with the HPMS approach.[25] Evidence of progress to date is the recent FHWA decision to modify TWS site selection guidelines so that States are encouraged to sample from HPMS locations.[26]

The method of collection for TWS data is imprecise—using one or more observers to classify vehicles moving in the traffic stream can pose problems in high-volume locations, poor lighting, and bad weather. Furthermore, since each State determines its method for establishing vehicle classification and truck weight (see figure 7-2), the error in the estimates may vary.

Industry Sources

Trade organizations generally do not keep commodity flow or truck population and mileage data. The American Trucking Associations (ATA), for example, keeps only aggregate statistics on tons and ton-miles derived from reports filed with ICC. The firms that submit the data are principally less-than-truckload common carriers, so the data lack information about bulk shipments and private carriage operations. Shipper organizations, like the American Petroleum Institute and the Chemical Manufacturers Association, are in much the same position as ATA. The Motor Vehicle Manufacturers Association maintains statistics on truck registrations derived from self-reported factory sales data provided by truck manufacturers.

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[23] Federal Highway Administration, op. cit., footnote 19.

[24] Ibid., p. 20.

[25] Federal Highway Administration, *Development of a Statewide Traffic Counting Program on the Highway Performance Monitoring System* (Washington, DC: U.S. Department of Transportation, March 1984).

[26] These guidelines have been included in the Federal Highway Administration, *Traffic Monitoring Guide* (Washington, DC: U.S. Department of Transportation, June 1985).

Some individual carriers, however, do keep data on their own movements. Large trucking firms generally keep computerized traffic databases that include origin, destination, commodity (by a variety of codes), shipment weight, and shipment date. Major shippers, like the large chemical and petroleum companies, also keep computerized data on their truck shipments.

National Motor Truck Data Base

Started under contract with the Association of American Railroads in 1977, the National Motor Truck Data Base contains information on approximately 36,000 movements per year. The data are collected at 18 selected truck stops, typically in the West and Midwest, in an attempt to sample long-haul moves selectively. For the shipments it covers, the database includes origin city and State, destination city and State, commodity, vehicle and operator characteristics, and an operator profile. The data are sometimes cross-checked against fuel sales at the truck stops and against volume counts on selected Interstates.[27]

Concerns over the utility of this database focus on the sampling approach and the survey design. The survey deals primarily with driver perceptions and statements about what they do and believe; it is thus subject to question as an indicator of actual behavior.

National Truck Trip Information Survey

UMTRI has recently developed an independent survey—the National Truck Trip Information Survey (NTTIS)—based on information at the trip level rather than at the level of a vehicle's annual mileage. The owner of each vehicle in the survey is contacted by telephone four times a year and asked about the vehicle's usage on a random day. The information includes trailer usage, cargo and cargo weight, and driver age for each trip. The trips are split into daytime and nighttime mileage, and each trip is mapped to distinguish urban and rural highway use. Roads are also divided into limited access highways, other major highways, and other roads.

By summing the data for all trips, annual mileage can be estimated by company type, power unit, number of trailers, trailer type and body, cargo, actual cargo weight, actual combination gross weight, driver age, and highway type. A sample of 8,144 vehicles was originally drawn from State registration files maintained by a national data firm, R.L. Polk, from which a subsample of 5,000 vehicles was used for the mileage survey. Response rates have been averaging 85 percent, roughly similar to response rates achieved by the TIUS.[28]

Preliminary analysis of the aggregated NTTIS data yields estimates that are roughly comparable to the TIUS in the total number of heavy trucks, configuration, and cab style, validating results of the TIUS and thus providing valuable information. The average daily mileage from TIUS data is slightly higher than similar estimates derived from NTTIS data.

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[27] Office of Technology Assessment, op. cit., footnote 2, p. 48.

[28] University of Michigan Transportation Research Institute, *The UMTRI Research Review*, vol. 17, No. 1, July-August 1986.

INSPECTION AND ENFORCEMENT DATA

Government oversight activities directed at carrier, driver, and vehicle qualifications have grown considerably in recent years, particularly at the State level. In support of these activities, a large amount of data has been collected and maintained for monitoring compliance. This information is also useful in assessing safety in the industry.

Federal Activities

Inspection, compliance, and enforcement actions taken by FHWA are included in MCMIS. Inspection activities consist of two separate reporting procedures, one for driver-vehicle roadside inspections and the other for motor carrier safety audits.[29]

The driver-vehicle inspection report documents findings of roadside inspections of drivers and vehicles conducted by FHWA field personnel and State personnel under the Motor Carrier Safety Assistance Program (MCSAP). The inspection program and reporting form have undergone considerable change since their inception in 1968, making the data inconsistent, a problem compounded by the unequal quality of information collected. For example, the information obtained from drivers is sometimes incorrect and/or obsolete, and many other fields in the report are incomplete, because of the limited information available to investigators at the time of inspection.

As of October 1, 1986, safety management audits have been handled through a three step process to 1) provide technical assistance and evaluate safety fitness; 2) assess compliance with recommended changes; and 3) pursue enforcement actions if compliance is unsatisfactory. The new system replaces the previous safety management audit and includes several reporting forms that are coded into MCMIS for later use.

The first step, a safety review, is compiled on form SR-1. Carriers are selected using sampling techniques to improve program efficiency and increase the number of safety contacts made annually. The SR-1 is used to determine whether the company has an adequate safety program in place. Additionally, the SR-1 is used to establish "safety fitness ratings" for the approximately 185,000 motor carriers that have not been previously evaluated by FHWA.

To assure the close monitoring of companies identified as having safety problems and to pursue enforcement actions, a selective compliance and enforcement program has also been established. Companies with unacceptable safety fitness ratings are subject to a compliance review, using form CR-1. The compliance review is a followup, on-site assessment to determine if a new rating is warranted or whether enforcement action is necessary. If enforcement action is required, such action is recorded on form 33B. Data from this form supplement an enforcement file, which FHWA has been using for years to track the status of legal actions taken against motor carriers or shippers in noncompliance with the safety regulations. This program also includes a component for monitoring companies that are in compliance, but are overrepresented in carrier/driver/vehicle at-fault accidents. The goal is to identify problem areas and implement safety countermeasures that could reduce at-fault accidents.

State Programs

Several States conduct roadside inspections as part of MCSAP. To satisfy reporting requirements to FHWA, these States maintain aggregate records on the vehicles inspected and on related findings. The information collected includes the number of inspections; driver violations, such as hours of service and medical certificate; vehicle defects, such as brakes, coupling devices, and exhaust systems; and proper adherence to hazardous materials regulations. Violations requiring immediate out-of-service action are tracked separately. As MCSAP continues to grow, it will also be possible to track inspection findings to support trend analyses. The level of sophistication in storing and maintaining these data varies considerably across States.

A second MCSAP-supported State activity is the conduct of safety management audits (Federal SR-1 and in-depth safety audits) by State inspection personnel. Fewer States conduct audits than do roadside inspections; however, increased emphasis is now being placed on terminals. States with exemplary

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[29] R.P. Landis, Federal Highway Administration, personal communication, Apr. 17, 1987.

Photo credit: California Department of Transportation

State inspectors are vital contributors of highway safety data.

terminal audit programs include Washington, Oregon, Idaho, and Alaska, participants in a pilot Federal program. In Oregon, for example, the audit database includes the number of vehicles each carrier operates, the type of payroll system used by each carrier, time documents or logbooks, hazardous materials transport violations, and maintenance functions. These data are cross-checked to make sure that the companies are not passing off fictitious paperwork as true safety programs. Trucks can be traced and cross-referenced in the database either by their vehicle license numbers or by the Oregon Public Utilities Commission plates of all vehicles based in Oregon.[10] The current MCMIS has capabilities similar to the Oregon system's, with the exception of some design specifications included in Oregon to accommodate State-specific needs.

The wealth of information potentially available for State inspection activities will be pooled by FHWA into a national database as part of SAFETYNET, the Motor Carrier Safety Information Network. SAFETYNET is a database management system designed to support MCSAP. The first component of the system will allow States to manage data collected during the inspection process. The key to the system is the development of a standardized format that permits individual States the flexibility to include additional data to satisfy specialized information needs. In theory, an individual State will be able to retrieve from the database a complete record on a carrier that also operates in other States. SAFETYNET is envisioned as a more comprehensive system that could potentially include accident and safety management information.[11]

MARKET AND FINANCIAL DATA

Under the present deregulated environment, tracking carrier entry into and out of the marketplace and tracking the impact of financial performance on safety investment are important for ensuring safety. Several useful sources of information are available for these purposes.

Interstate Commerce Commission

ICC has long had primary responsibility for monitoring economic activities in the interstate trucking industry. Prior to 1980, ICC required annual reports from virtually all motor carriers of property, Classes I, II, and III. Very small Class III carriers, those with annual revenues under $500,000, were exempted from the annual report filing requirement. Over time and through rulemaking, ICC has reduced reporting requirements for motor carriers of property. Also, revenue levels for the various carrier classes (see below) have been raised over time, also reducing reporting requirements. Further, since ICC no longer analyzes these data on many of the

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[10] Larry Koeneke, State of Oregon, personal communication, April 1987.

[11] *Safety Network News*, vol. 1, No. 1, fall 1986.

carrier segments, it has granted exemptions from the reporting requirements to many firms simply because they asked to be exempted.[32]

The first change in reporting requirements affected Class III carriers, and by 1981, Class III firms were no longer required to file any financial reports. In dropping these requirements, ICC relinquished any possibility of tracking progress made by these firms, even if they subsequently grew to Class I or II status. All motor carriers granted their initial ICC operating authority are originally classified as Class III. Thus, virtually no data exist for new entrants.[33]

Also, in 1980 a number of other changes affected reporting requirements. First, ICC raised carrier revenue limits. Class I carriers were redefined from annual revenues of $3 million or more to $5 million or more. Class II revenue levels were raised from the $500,000 to $3 million range to a $1 million to $5 million range. Class III, previously under $500,000 in revenues, was raised to under $1 million. Because of this change, a number of firms previously filing the Class I and II annual report fell back to the (exempt) Class III group. It is estimated that some 500 carriers were "lost" as a result.[34]

During this time, ICC also began granting exemptions to Class I and II carriers from the annual reporting requirements. In 1980 alone, 324 Class I and II carriers were exempted, and more have been added to this list in recent years.

At one time, the data from annual reports provided sufficient detail to track freight activities at several levels by type of carrier, commodities carried, services provided, size of operation, expenditures and income, and vehicle utilization. However, ICC has reduced the amount of information required on the report form as well as reducing the reporting population. At the present time, annual report data are collected only from Class I and II carriers (those not given exemptions). A recent initiative by ICC to dispense with its accounting system and to reduce annual report forms to one page was contested vigorously by several interest groups. However, ICC's proposed rulemaking effectively reduced the number of motor carriers reporting to ICC from 2,500 to 950 and permitted carriers to use alternatives to the uniform accounting system. Since January 1, 1987, the annual report form has contained only 10 pages, a considerable reduction over previous requirements, although the requirements are under review.[35] ICC data are maintained by the American Trucking Associations and include extensive error-checking programs to verify the accuracy of reported information.

Dun & Bradstreet

The actual number of companies entering and leaving the trucking industry is tracked by Dun & Bradstreet. New entries are monitored by Dun & Bradstreet through sources such as requests made to ICC for operating authority. Carrier failures are monitored by Dun & Bradstreet reporters, who are assigned to local jurisdictions to examine court records daily concerning bankruptcy filings. Companies are categorized by the Standard Industrial Classification system, although the reliability of the process used to assign trucking companies to appropriate classifications is a concern. Because of the structure of the database, mergers and changes in ownership cannot be identified through Dun & Bradstreet.[36]

The Insurance Industry

The insurance industry is understandably concerned about the financial solvency of the motor carriers its members consider for coverage. Although some financial records exist in-house, the industry also contracts with outside firms to gather additional financial data. This information is drawn from several State regulatory agencies where carriers are registered and from the more limited data available through ICC.[37]

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[32] Ronald D. Roth, American Trucking Associations, personal communication, Mar. 24, 1987.

[33] Ibid.

[34] Ibid.

[35] *Traffic World*, "Agency Eases Rules on Accounting, Reporting for Regulated Truck Lines," Apr. 6, 1987; and Ronald D. Roth, American Trucking Associations, internal memo, Jan. 15, 1988.

[36] Tiziana Mohorovic, Dun & Bradstreet, personal communication, July 21, 1987.

[37] Andrew Schindel, Central Analysis Bureau, personal communication, July 21, 1987.

CONCLUSIONS AND POLICY OPTIONS

Accurate, uniform, and representative information about heavy vehicle safety matters is essential, so that effective programs for improvements can be developed. **However, OTA finds that with few exceptions, existing information systems have deficiencies that limit their value in supporting safety policies and programs.** In general, data collected are of questionable usefulness for one or more of the following reasons: 1) poor data element design and lack of uniformity, 2) little or no quality control of the data collected, or 3) poor or nonexistent data handling and storage systems. Although it is virtually impossible to design and collect the "perfect" database, and some of the existing data are useful for analyzing narrow, specific truck safety issues, truck safety information systems lag considerably behind their modal counterparts in coverage and accuracy.

Accident Data

None of the national accident databases is ideally suited for addressing all the important motor carrier safety issues (see table 7-1). The MCMIS accident file lacks adequate information on the accident experiences of most intrastate carriers. The FARS database is a census for only one small subset of accidents (fatal accidents), and it does not distinguish all truck types.

NASS offers the advantage of selecting accidents by a statistically based sampling scheme, permitting the derivation of national accident totals and annual trends. However, the changes made to NASS for 1988 are likely to make it more difficult to conduct detailed motor carrier accident causality studies using this database.

State accident reporting systems present several promising alternatives because they can represent a census of accidents, and many States have begun to include additional fields for truck details. However, the lack of uniformity between States' data presents problems for extrapolating findings to the national level. The efforts of NHTSA in establishing the CARDfile, and of CVSA and the National Governors' Association in striving for more uniform State accident reporting practices are commendable.

OTA finds that a NASS-style approach could be a cost-effective base for a truck accident data system, for it allows a sampling of truck operations by both geography and road use. To provide accurate and comprehensive information, each accident investigation could be handled by a field staff that examines the vehicle and the accident site, interviews vehicle occupants, and reviews medical and driver records. Finally, the report form could include the necessary detail on truck vehicle and operating characteristics to permit the type of study needed for performing component safety analyses. For this option to be effective, additional funds will be needed both to restore the original approach and to expand the system to meet truck safety concerns. **Furthermore, OTA concludes that training field teams in truck accident investigation so that vehicle-related factors are examined thoroughly will be necessary.**

Another alternative is the development of a completely independent truck accident data collection system patterned after the NASS design. This approach would permit selection of sampling units solely on truck criteria rather than for all motor vehicles. Such a program would be more costly because a new, independent system would have to be developed. However, the system could provide the type of detail needed to support better analysis of motor carrier safety needs. NHTSA's advice and expertise would be valuable regardless of whether NHTSA or FHWA took the lead on such an initiative.

Congress may wish to consider requiring the Department of Transportation to focus on coordinating and improving existing accident databases and to take steps to develop a NASS focused on heavy vehicles. At a minimum, FHWA programs that encourage States to expand accident report forms to accommodate truck detail and to establish uniform reporting thresholds and forms for a minimum core of data elements could be aggressively pursued. This would improve available truck safety information and would move toward a national census of accident history that could be used for analysis. **OTA concludes that NHTSA analysis of motor carrier accident data has not been sufficient to support regulatory initiatives, particularly**

those related to the key areas of driver training and performance. This shortcoming is serious, given the preponderance of human error among accident causal factors. **Congress may wish to require DOT to address this issue. Coordination between FHWA and NHTSA is essential.**

Exposure Data

OTA finds that uniformity between accident and exposure data, and accuracy in estimating truck movement independent of accident rate formulation (see table 7-2) are priority needs. Each existing exposure database has a different limitation. However, FHWA's work with the States on exposure has promise. For example, the HPMS and TWS could be merged to form a national exposure data collection system that still meets the original objectives of each database. The level of detail collected by HPMS and TWS is sufficient for a truck exposure database, provided that information on the driver is included in the survey. FHWA is already in the process of resolving some of the issues involved in developing such an exposure system.[38]

TWS data could be collected from sample sites drawn from each HPMS functional classification stratum. Classification counts could be scheduled to take place at each site around the clock at periodic intervals. Truck weight sites would be selected from sites identified for vehicle classification, recognizing that some sites are more conducive than others for vehicle weighing and survey administration. Such a program would allow derivation of national exposure estimates by road type, vehicle, carrier, and driver. Also, if the statistical design for both the accident and exposure databases were properly formulated, accident rates could be established without necessarily having the same accident and exposure reporting sites.

As an initial step, **Congress may wish to consider extending FHWA's reporting requirements to include all motor carriers, including intrastate and those currently exempt from Federal reporting requirements.** Using SAFETYNET as a model, a Federal-State cooperative truck registration database could be developed. State vehicle registration requirements could incorporate carrier identification and exposure information for entry into the database.

An alternate approach could include a Federal requirement for a brief annual report by intra- and interstate carriers to FHWA. Useful information would include carrier's name, address, telephone number, the number of trucks and buses with identifying numbers, categories of vehicles, and miles traveled annually. The cost to the Federal Government would be minimal; additional staff would be required for information processing. The information would provide valuable data about exposure and distribution. **Congress may wish to consider legislation enabling DOT to implement this reporting requirement.**

The cost of both accident and exposure data collection programs is a function of the desired precision in the estimates. The variance of recorded measures both within and between sampling units has an impact on the number of units and observations required. To achieve reasonable confidence levels for accident rates between truck types, close to 300 sampling units would be required at a total annual cost of close to $2 million. Furthermore, the logistical demands of establishing and maintaining cooperative arrangements with each jurisdiction are formidable.

If these obstacles are insurmountable, more economical alternatives can be considered, focusing primarily on expanding existing data collection instruments, such as the Motor Carrier Census, that are producing some useful information. However, the deficiencies that are associated with each of these approaches are likely to persist. **OTA concludes that the importance and scale of activity of the trucking industry, and the high costs associated with heavy vehicle accidents make these important issues for Congress to weigh.**

Inspection and Enforcement Data

A wide range of inspection and enforcement data is being amassed (particularly at the State level) that will provide useful information for safety analyses (see table 7-3). Although the process by which vehicles and companies are targeted for inspection varies between States, the inspection results are reported in a uniform way. SAFETYNET must ma-

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[38] Federal Highway Administration, op. cit., footnote 25.

Table 7-2.—Truck Safety Information Resources (Exposure Data)

Database	Kept by	Years	Strengths	Weaknesses
TIUS	Bureau of the Census	Every 5 years, most recently in 1982	• Covers all trucks used in the United States • Sample biased toward heavy trucks • Exclusive truck focus	• No commodity flow data • Only rudimentary commodity information • Reflects tractor use, not trailer use • Based on owner response
CTS	Bureau of the Census	Since 1963, every 5 years	• Multimodal • Cross-checked against the Census of Manufacturers • Provides flow data	• Shipment data on some products are missing • Only shipments from point of manufacture to first destination are reported • Nonuniformity between surveys • Voluntary data submission
Motor Carrier Census File (part of MCMIS)	FHWA	Most recent 5 years	• Comprehensive listing of carriers and truck fleet operators • Exclusive truck focus	• Many carriers missing from data base • No commodity flow data
HPMS	FHWA	Annually	• Statistical sampling design • Detail on roadway characteristics	• Limited truck classification detail
TWS	FHWA	Annually	• Truck classification and weight data • Exclusive truck focus	• Counting sites are not statistically representative • Method of data collection varies and is subject to observer error
Motor carrier industry	Individual carriers, trade associations		• Aggregate statistics on tons, ton-miles, and truck registrations • Detail flow records from individual carriers and shippers; can merge with similar accident records • Exclusive truck focus	• Truck data are based principally on LTL carriers • Individual carrier represents single observation in industry • Access to individual carrier records is not in public domain
NMTDB	Transportation Research and Marketing (consulting firm)	1977 to present	• Focuses on long-distance truck movements • Good truck and operator classification detail • Exclusive truck focus	• Purposely excludes short-haul truck movements, especially in Northeast • Not in public domain
NTTIS	UMTRI	1986 to 1987, single collection	• Good truck and operator classification detail • Disaggregate and aggregate analysis possible • Exclusive truck focus	• Relatively small number of observations • Single collection

KEY: TIUS = Truck Inventory and Use Survey.
CTS = Commodity Transportation Survey.
MCMIS = Motor Carrier Management Information System.
FHWA = Federal Highway Administration.
HPMS = Highway Performance Monitoring System.
TWS = Truck Weight Study.
LTL = less-than-truckload.
NMTDB = National Motor Truck Data Base.
NTTIS = National Truck Trip Information Survey.
UMTRI = University of Michigan Transportation Research Institute.

SOURCE: Office of Technology Assessment, 1988.

Table 7-3.—Truck Safety Information Resources (Inspection and Enforcement)

Database	Kept by	Strengths	Weaknesses
MCMIS (driver-vehicle inspection review, enforcement)	FHWA, Office of Motor Carriers	• Part of comprehensive safety information system • New program initiated in 10/86 will add safety management audit activities • Exclusive truck focus	• In the past, quality of information collected has been poor • Quality of new program data collection unknown
State programs	Various State regulatory agencies (MCSAP)	• Roadside and safety management audits • Development of uniformity to permit interface at a national level through SAFETYNET • Exclusive truck focus	• Not all States currently participate • Successful implementation of SAFETYNET unknown at this time

KEY: MCMIS = Motor Carrier Management Information System.
FHWA = Federal Highway Administration.
MCSAP = Motor Carrier Safety Assistance Program.

SOURCE: Office of Technology Assessment, 1988.

ture before its information can be available in an automated form on a national scale. The new procedure developed by FHWA for handling safety management audits is such a recent development that the contribution of this effort to the quality of available information is largely unknown. **OTA concludes that an enforcement information database will provide a valuable resource for Federal and State safety oversight. Congress may wish to continue Federal support for this program.**

Market Entry, Exit, and Financial Data

Little information is publicly available on the financial condition of motor carriers, and the direction in the past 8 to 10 years has been toward curtailing reporting requirements (see table 7-4). **OTA concludes that the ICC reporting system no longer adequately monitors carrier market entry, exit, and financial performance. The current lack of information presents a significant problem for both safety-related and broad policy decisions.** A data collection effort that includes Class III carriers, scrutinizes requests for exemptions, and maintains sufficient detail in the data elements to track financial performance would serve a useful purpose for evaluating truck safety.

Table 7-4.—Truck Safety Information Resources (Market Entry, Exit, and Financial Performance)

Database	Kept by	Strengths	Weaknesses
ICC	ICC	• Primary source of financial data on carriers • Excellent historical detail • Exclusive truck force	• Intrastate carriers not included; elements of interstate market missing owing to exemptions and changes in reporting requirements • Little concern over reporting compliance • Diminishing financial detail with new reporting requirements
Insurance industry	Individual insurers, Central Analysis Bureau	• Collectively utilizes best financial information available for each carrier under evaluation • Exclusive truck focus	• Relies on developing composite picture from variety of sources
Dun & Bradstreet	Dun & Bradstreet	• Monitored based on filings for operating authority and bankruptcy • Exclusive truck focus	• Aggregate data reporting, classification problems • Merger and change in ownership cannot be identified

KEY: ICC = Interstate Commerce Commission.

SOURCE: Office of Technology Assessment, 1988.

Appendixes

Appendix A

List of Acronyms

AADMVA	—American Association of Motor Vehicle Administrators
AASHTO	—American Association of State Highway and Transportation Officials
ALV	—automatic brake pressure limiting valve
ATA	—American Trucking Associations
BAC	—blood-alcohol concentration
BMCS	—Bureau of Motor Carrier Safety (now OMC)
CARDfile	—Crash Avoidance Research Datafile
CDL	—Commercial Driver's License
CDS	—Crashworthiness Data System
COE	—cab-over-engine
CTS	—Commodity Transportation Survey
CVSA	—Commercial Vehicle Safety Alliance
DOT	—U.S. Department of Transportation
FARS	—Fatal Accident Reporting System
FHWA	—Federal Highway Administration
FMCSR	—Federal Motor Carrier Safety Regulations
FMVSS	—Federal Motor Vehicle Safety Standard
GES	—General Estimates System
GVW	—gross vehicle weight
HPMS	—Highway Performance Monitoring System
IBT	—International Brotherhood of Teamsters
ICC	—Interstate Commerce Commission
IIHS	—Insurance Institute for Highway Safety
ISO	—Insurance Services Office, Inc.
LCV	—longer combination vehicle
LTL	—less-than-truckload
MCA	—Motor Carrier Act (1935, 1980)
MCMIS	—Motor Carrier Management Information System
MCSAP	—Motor Carrier Safety Assistance Program
MVMA	—Motor Vehicle Manufacturers Association
NASS	—National Accident Sampling System
NGA	—National Governors' Association
NHTSA	—National Highway Traffic Safety Administration
NMTDB	—National Motor Truck Data Base
NPTA	—National Private Trucking Association
NTSB	—National Transportation Safety Board
NTTIS	—National Truck Trip Information Survey
OMC	—Office of Motor Carriers
PCC	—Private Carrier Conference
PMI	—preventive maintenance inspection
PTCA	—Private Truck Carriers Association
PTDIA	—Professional Truck Driver Institute of America
RCCC	—Regular Common Carrier Conference
RSPA	—Research and Special Programs Administration
SEP	—State Enforcement Plan
STAA	—Surface Transportation Assistance Act of 1982
TIUS	—Truck Inventory and Use Survey
TL	—truckload
TRB	—Transportation Research Board
TSI	—Training Safety Institute
TWS	—Truck Weight Study
UMTRI	—University of Michigan Transportation Research Institute
UPS	—United Parcel Service

Appendix B

Workshop Participants, Reviewers, and Contributors

Workshop Participants

Participants in Technologies Affecting Truck Safety Workshop, March 10, 1987

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